Tappi

PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

NOVEMBER 1951

PEXOL*

(HERCULES FORTIFIED SIZE)

AN IMPORTANT DEVELOPMENT FOR PAPER MAKERS

Hercules' Pexol, formerly known as Dresinate® 209, is gaining wide use among paper mills all over the country.

Why?

Because this fortified rosin size is cheaper to use than conventional sizes—mill operators report that Pexol is highly efficient, particularly for difficult sizing problems.

Pexol is readily available in paste or dry form. Try it and prove to yourself how this fortified rosin size can help you solve difficult sizing problems and save money, too.

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SIZE-AID*

GAINS WIDE USE, TOO

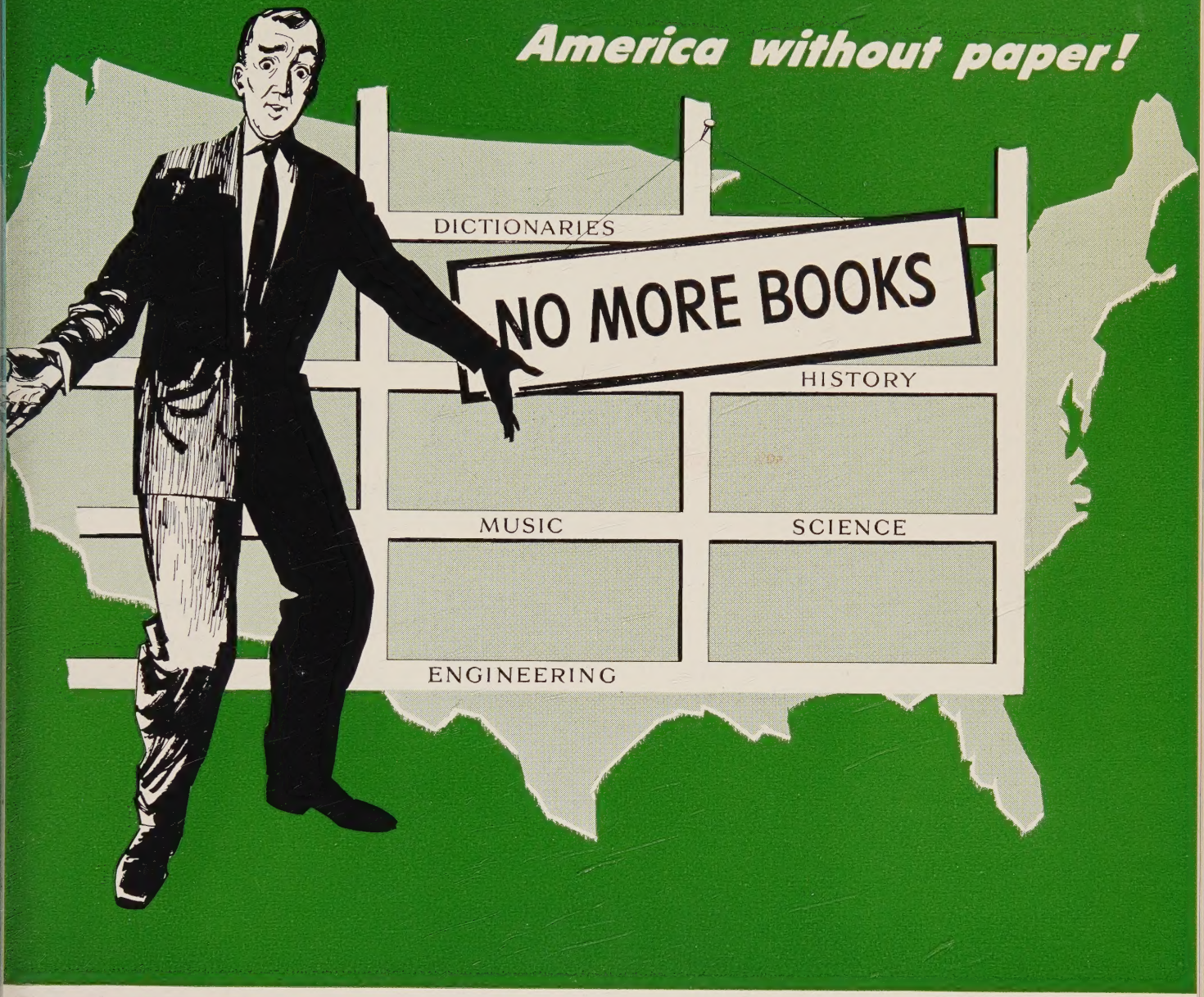
Hercules' Size-Aid, formerly known as Dresinate® 211, is a dry, concentrated size additive formulated to increase the efficiency of rosin size.

HERCULES POWDER COMPANY
INCORPORATED
Paper Makers Chemical Dept., 967 King Street, Wilmington, Dela.

*TRADE-MARK

IMAGINE...

America without paper!



Imagine a people without paper . . . a nation without benefit of the printed word! No printers . . . no publishers . . . and soon the libraries and bookshops . . . the storehouses of America's knowledge and know-how . . . would be obsolete. In such a paperless void, news, ideas, and information vital to the nation's strength and security would come to a dead stop. Even voice communication . . . America's telephone, telegraph, radio and TV networks . . . would quickly become silent. *Unthinkable?* Don't take paper for granted. Anything so vitally basic should be safeguarded. America *depends* on paper! Use paper wisely . . . protect its production . . . to keep America strong.

America depends on

PAPER

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MAKERS OF HIGH-SPEED, HIGH-PRODUCTION PAPER MACHINERY SINCE 1858

CAN YOU USE REPRINTS? This is one of a series of messages Beloit is running in *Fortune* Magazine to remind the U. S. of paper's importance. Reprints for bulletin boards and mailing available. Write to Beloit Iron Works, Beloit, Wis.

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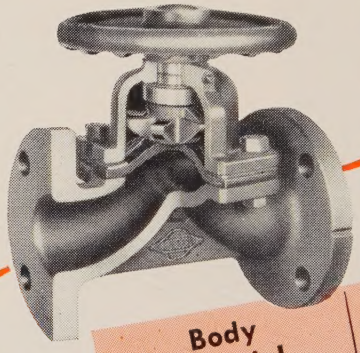
Fluid	Concentration	Temp.	Type of Valve	Valve Material
1 Sulphuric Acid	20%	120 F.		
2 Sulphuric Acid	100%	180 F.		
3 Hydrochloric Acid	32%	80 F.		
4 Hydrofluoric Acid	50%	125 F.		
5 Beer		200 F.		
6 Oxygen		Ambient		

In several of these cases other body materials or diaphragms would serve as well. But the really important fact is the unmatched versatility of Grinnell-Saunders Diaphragm Valves in handling corrosive fluids, gases, compressed air, food and suspended solids . . . in lines where corrosion, abrasion, contamination, clogging, leakage and maintenance are problems.

Grinnell-Saunders Valve bodies are stocked in cast iron, malleable iron, stainless steel, bronze, and aluminum, with other materials available on special order. Valve bodies can be lined with lead, glass, natural rubber or neoprene. Diaphragms are available of natural rubber and a number of synthetics to suit particular service conditions.

The Grinnell-Saunders Valve Division will be pleased to submit recommendations upon receipt of complete information covering service conditions.



We supplied Grinnell-Saunders Diaphragm Valves with . . .

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2 Cast iron	KEL-F
3 Glass lined	Butyl
4 Magnesium	KEL-F
5 Polished bronze	White diaphragm
6 Cast iron*	Neoprene

*For oxygen service a high flash point lubricant is supplied. All valves for oxygen service are subjected to 300 lb. air underwater test.

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- diaphragm lifts high for streamlined flow in either direction
- diaphragm presses tight for positive closure
- body, lining and diaphragm materials to suit service
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A better way

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patent pending

to wash pulps!

The use of pressure to wash pulp, instead of the vacuum or diffusion principle, has been under development for many years. Now, climaxing this research, the Pressure Washing System is offered to the industry as a commercially-proved method, applicable to both chemical and semi-chemical pulps. Here are some of the advantages it offers you:

High capacity—*300 A.D. tons per day plus*

Low power requirements

Low water consumption

Extremely flexible installation

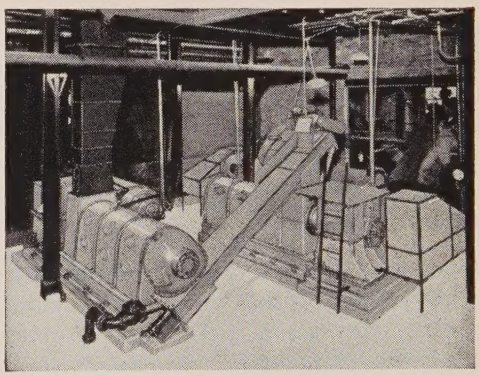
Low capital investment

Low maintenance costs

Low labor costs

No foam

Clean pulp—*to meet any specifications*



A three-stage washing installation on kraft. Pulp passes through the press on left, up inclined screw conveyer, and through press in center. Final press is shown in rear.

Last, but not least, Pressure Washing offers reduction of stream pollution and savings in evaporator costs that are unparalleled. Systems can be furnished in two, three, and four stages to fit individual mill requirements. Write for complete information on this revolutionary development.

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SUTHERLAND, Inc.

Sales & Service

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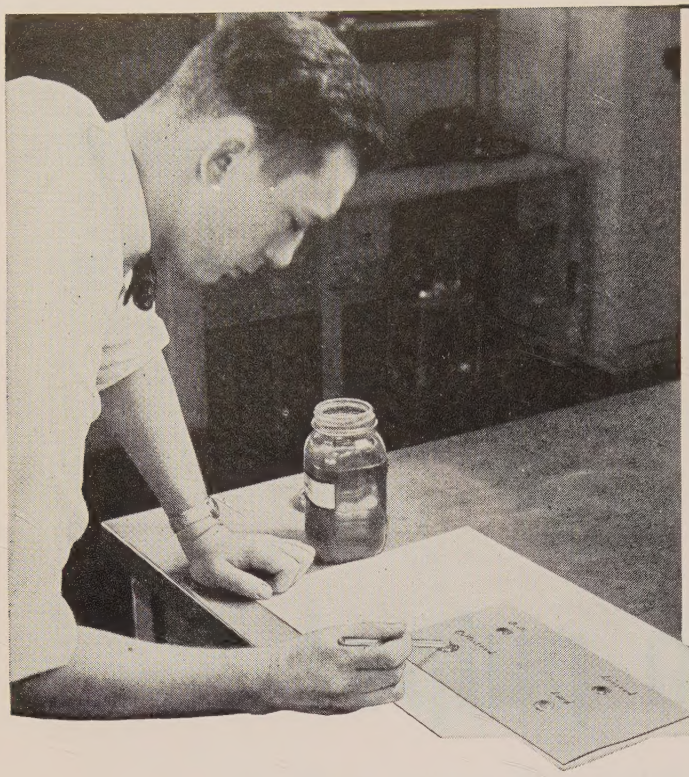
Manufactured by VALLEY IRON WORKS CO., Appleton, Wisconsin



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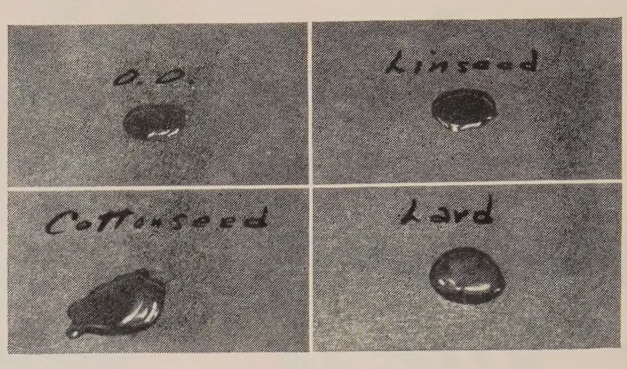

GREASE TEST—HOURS FOR PENETRATION

	Kraft	Chipboard
Olive Oil	120 +	120 +
Lard	120 +	120 +
Cotton Seed Oil	120 +	120 +
Linseed Oil	120 +	120 +

Best for coatings and impregnants—

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PAPERMAKERS everywhere are turning to Goodyear to meet their needs for coatings and impregnants with a wide range of properties. For in the **Pliolite** and **Chemigum** families of latices there is a choice of materials which will enable papermakers to "tailor" their output to meet the exact requirements of their customers.

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Latices are also in use as sizings, binders and adhesives. Although these use-proved products are currently in short supply, we will gladly give you full assistance and samples for your laboratory evaluation.

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GOODYEAR

Pliolite, Chemigum—T. M.'s The Goodyear Tire & Rubber Company, Akron, Ohio

NOVEMBER 1951

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Warm up

before the game

An old duffer we know told us that.
He'd say, "Ever notice how much better you do on the back nine? That's because you've warmed up on the front nine. So get smart and warm up before the game!"

That's why we're asking you right now to start thinking of the advantages of buying your caustic soda from Wyandotte. . . . Even though we've got little to sell you, unless you're a customer of record.

Come to think of it, that's a pretty good reason to figure on doing future business with us. Because we're a source you can depend on.

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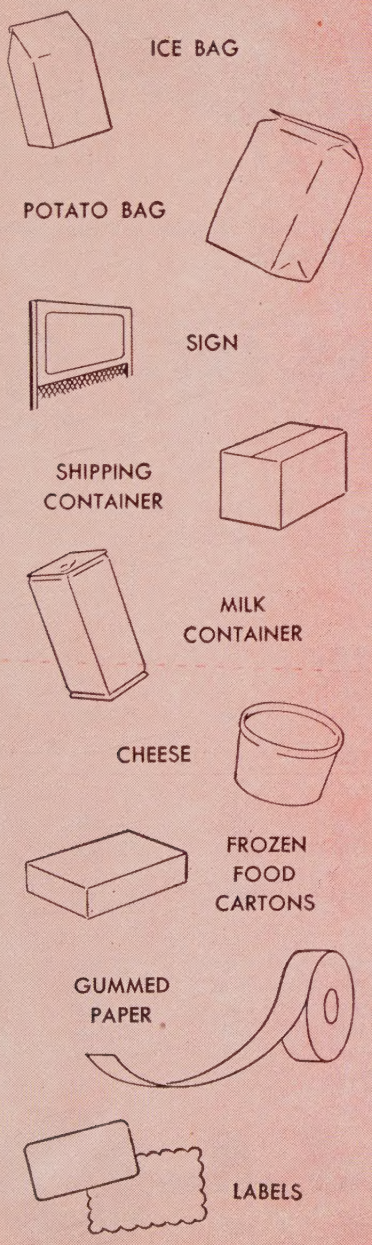

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Offer *signboard* and *poster papers* with good durability and printing properties.

Introduce water-repellent *shipping containers* for wet vegetables, sea foods—use in refrigerated storage.

Develop blood and serum resistance on *meat wraps* and *board*—reduce sticking of meats to paper.

WAX ANCHORAGE

Improve rigidity—lower seam liquid absorption on *liquid-tight containers.*

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RELEASE

Produce paper backings for *pressure-sensitive labels* which "strip" easily.

Minimize blocking tendencies on *gummed and pressure-sensitive tapes.*

Develop exceptional anti-blocking characteristics on *non-fibrous papers.*

Eliminate fiber-pull upon separation of adjacent *frozen packages—cartons.*

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Modify *glue-gelatin* to produce more water-resistant films or coatings.

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PLANNED NEW CAPACITY FOR THE PAPER AND BOARD INDUSTRY

Survey made by the American Paper and Pulp Association

THE following is the tabulation of the annual survey of new capacity for 1951, 1952, and 1953 for the paper and board industry, and a summary of new capacity for 1951 and 1952 for wood pulp. Data for 1951 and 1952 for the paper and board industry represent a revision of previously published capacity because installations of new machinery and improvements of existing machinery may not occur when scheduled. Wood pulp capacity has been included in this report for the first time. This report may be summarized as follows:

	Total wood pulp, tons	*Total paper and board, tons*	*Paper, tons*	*Board, tons*
Estimated capacity, end of 1950	16,166,693	24,480,820	12,562,620	11,918,200
end of 1951	17,583,063	25,279,225	13,001,735	12,277,490
end of 1952	18,599,710	26,474,895	13,534,625	12,940,270
end of 1953		27,167,745	13,653,975	13,513,770
Percentage increase, 1951/1950	+ 8.8	+ 3.3	+3.5	+ 3.0
1952/1950	+15.0	+ 8.1	+7.7	+ 8.6
1953/1950	...	+11.0	+8.7	+13.4

The cumulative increases shown above indicate a rate of increase in wood pulp capacity more than double that in paper and board capacity for 1951 and 1952. This may be related to two things: (1) the fact that for 1951 and 1952 85.5% of the total paper and board capacity increase is expected to take place in integrated mills, and (2) the preponderant increase in the wrapping and specialties and paperboard grades, the latter representing a large proportion of kraft board requiring the use of wood pulp as a raw material. The following table shows a breakdown of the total capacity increase between integrated and nonintegrated mills:

	Annual capacity, (tons) 1951	1952	1953
Nonintegrated	122,295	166,780	111,600
Integrated	676,110	1,028,890	581,250
Total	798,405	1,195,670	692,850

The detail of planned capacity increases in the various grades of paper and kinds of wood pulp will be found in the following tables. Data on wood pulp capacity are from the United Stated Pulp Producers Association, Inc. Through the cooperation of the Writing Paper Manufacturers Association, additional data on new papermaking machinery not reported to this Association have been included, so that the capacity for new machine installations is believed to be complete for the paper and board industry.

Survey of New Capacity—1951, 1952, 1953

Grade of paper	*Capacity increases, tons* 1951 Daily	1951 Annual basis	1952 Daily	1952 Annual basis	1953 Daily	1953 Annual basis
New Machines						
Fine	30	9,300	146	45,260	...	...
Book	...	...	70	21,700	...	...
Tissue	134	41,540	89	27,590	...	...
Wrapping and specialties	612	189,720	1096	339,760	250	77,500
Groundwood papers	60	18,600	...	...	...	...
Newsprint	...	...	100	31,000	...	...
Miscellaneous	8	2,480	...	...	...	...
Building paper	...	...	...	...	...	...
Total Paper	844	261,640	1501	465,310	250	77,500
Paperboard	520	161,200	1868	579,080	1850	573,500
Building board	150	46,500	...	...	...	...
TOTAL PAPER AND BOARD	1514	469,340	3369	1,044,390	2100	651,000
Rebuilt Machines						
Fine	(16)	(4,960)	10	3,100	10	3,100
Book	172	53,320	50	15,500	5	1,550
Tissue	37	11,470	80	24,800	45	13,950
Wrapping and specialties	300	93,000	78	24,180	50	15,500
Groundwood papers	14	4,340	...	...	25	7,750
Newsprint	63	19,530	...	...	...	...
Miscellaneous	2½	775	...	...	...	...
Building paper	...	...	...	...	...	...
Total Paper	572½	177,475	218	67,580	135	41,850
Paperboard	489	151,590	270	83,700	...	...
Building board	...	...	...	...	...	...
TOTAL PAPER AND BOARD	1061½	329,065	488	151,280	135	41,850

( ) indicates decrease due to grade shift.

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★

For Testing and Developing
Methods of Improving
Paper Products

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R. T. VANDERBILT CO., INC.

230 Park Avenue, New York City

Grade of paper	Capacity at end of 1950	Increases during 1951	Capacity at end of 1951	Increases during 1952	Capacity at end of 1952	Increases during 1953	Capacity at the end of 1953
	Capacity increases—new and rebuilt machines, annual basis, tons						
Fine	1,285,030	4,340	1,289,370	48,360	1,337,730	3,100	1,340,830
Book	2,520,440	53,320	2,573,760	37,200	2,610,960	1,550	2,612,510
Tissue	1,369,740	53,010	1,422,750	52,390	1,475,140	13,950	1,489,090
Wrapping and specialties	3,967,580	282,720	4,250,300	363,940	4,614,240	93,000	4,707,240
Groundwood papers	886,780	22,940	909,720	...	909,720	7,750	917,470
Newsprint	1,032,810	19,530	1,052,340	31,000	1,083,340	...	1,083,340
Miscellaneous	111,240	3,255	114,495	...	114,495	...	114,495
Building paper	1,389,000	...	1,389,000	...	1,389,000	...	1,389,000
Total Paper	12,562,620	439,115	13,001,735	532,890	13,534,625	119,350	13,653,975
Paperboard, including wet machine and building board	11,918,200	359,290	12,277,490	662,780	12,940,270	573,500	13,513,770
TOTAL PAPER AND BOARD	24,480,820	798,405	25,279,225	1,195,670	26,474,895	692,850	27,167,745

Expected capacity increases for the three years 1951, 1952, and 1953 by grades of paper and board are shown below, in tons, in per cent of total increase, and by percentages indicating the distribution of the capacity increases during the three-year period:

	1951–53 per cent capacity increase to total	1951–53 capacity increase, tons	Per cent of total 1951–53 increase, during 1951	1952	1953
Fine	2.1	55,800	7.8	86.7	5.5
Book	3.4	92,070	57.9	40.4	1.7
Tissue	4.5	119,350	44.4	43.9	11.7
Wrapping and specialties	27.5	739,660	38.2	49.2	12.6
Groundwood papers	1.1	30,690	74.7	..	25.3
Newsprint	1.9	50,530	38.7	61.3	..
Miscellaneous	0.1	3,255	100.0	..	..
Building paper	...	...	...	..	..
Total Paper	40.6	1,091,355	40.3	48.8	10.9
Paperboard, wet machine and building board	59.4	5,595,570	22.5	41.5	36.0
TOTAL PAPER AND BOARD	100.0	2,686,925	29.7	44.5	25.8

Annual Wood Pulp Capacity, 1950–52[a]

Grade of wood pulp	1950	Tons 1951[b]	1952[b]
Sulphite			
Total	3,044,365	3,131,278	3,182,844
Maximum bleaching	2,330,274	2,469,373	2,508,224
Sulphate			
Total	7,676,718	8,663,777	9,419,036
Maximum bleaching	2,089,692	2,367,421	2,697,510
Soda	540,406	463,322	498,497
Total chemical	11,261,489	12,258,377	13,100,377
Groundwood	2,871,316	2,948,887	2,981,185
Other grades	2,033,888	2,375,799	2,518,148
Total	16,166,693	17,583,063	18,599,710

[a] Reproduced from page 26 of *Wood Pulp Statistics*, published by the United States Pulp Producers Association, Inc., Aug. 1951. Data are compiled from reports of capacity of the United States Pulp Producers Association, Inc., by all but a few United States producers of wood pulp. Capacity for companies not reporting has been estimated.

[b] Preliminary and projected. These projected data include increases for only those companies who definitely plan to proceed with their reported expansion; planned capacity increases that have not yet reached the "action" stage have not been included.

Note: Capacity data above give the tonnage that could be produced during the stated calendar year with full use of equipment and an adequate supply of pulpwood and labor, with each mill operating the number of days it might expect to operate under normal conditions.

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Now you can defiber hard stock quickly, completely, at low cost with the new Cowles Pulper. The side drive design enables the use of relatively small, high speed impellers which are phenomenally efficient for pulping and defibering.

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—in a freshly coated calendered sheet!

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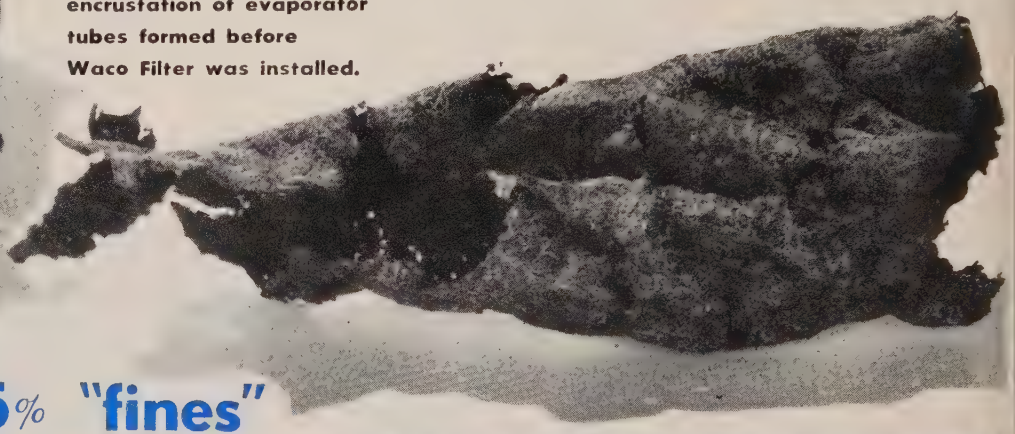

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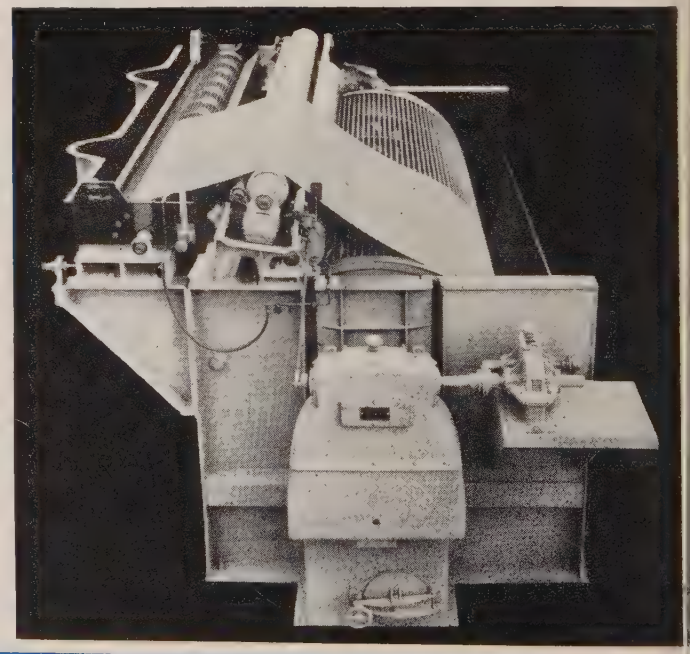

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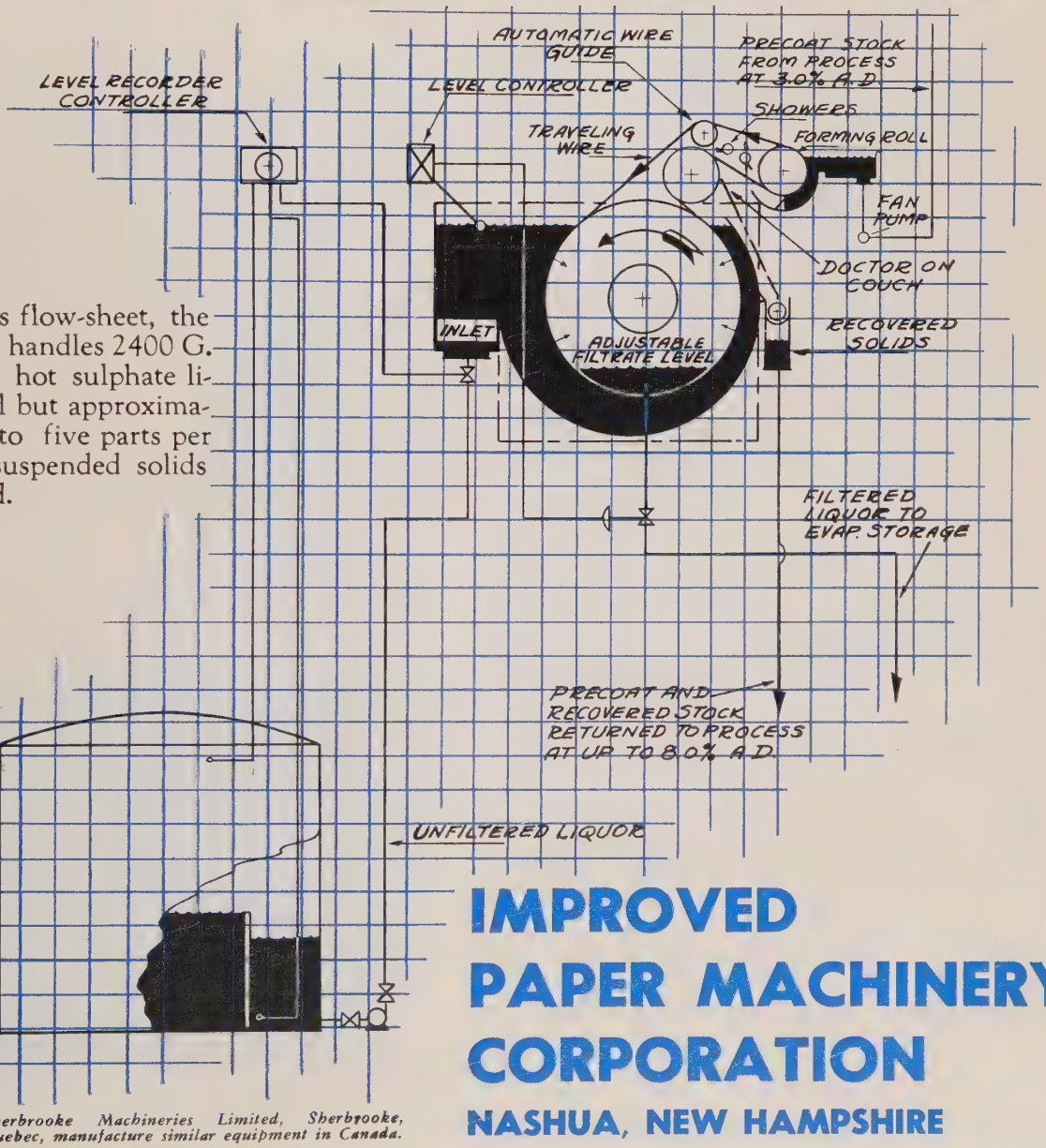

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Engineering in Forest Protection

G. I. STEWART

Forest protection is concerned chiefly with control of forest fire, but to this must be added the influences of insects and fungi. These last two are natural factors little subject to human control; for the most part they are endemic, although catastrophies occur when epidemic conditions become established. Protection of timber resources from insects and fungi has become a highly specialized science of the entomologist and of the pathologist, while fire control has become an engineering problem.

Prior to 1925 most fires were fought by manual means, and, on occasion, great numbers of men were employed on the larger ones. In many sections of the nation this practice still prevails; it is determined largely by circumstances of population, accessibility of wilderness areas, facilities for transportation, character of terrain, types and character of forest fuels. However, throughout the nation as a whole, modern fire control is accomplished through mechanization of equipment. As rapidly as these techniques can be applied, man power is being replaced by machines. Organizations maintained by leading states and the United States Forest Service employ skilled forces of modest numbers, and these are provided with modern apparatus of many kinds. As long as fire control was accomplished manually, it remained largely a problem of organization of man power but the transition to machine equipment changes it rapidly into a complex field of engineering.

BENEFITS OF MECHANIZATION

Many benefits are derived through mechanization. In most instances prompt attack on forest fire decides the issue. Skilled officers are trained to make necessary decisions when fire locations are reached, within the shortest possible time, and to put into use proper machines capable of performing the work required. Increase in efficiency of machinery as compared to man power, is most noticeable in the amount of physical work that can be done within the first working hour. Motorized transport assures prompt arrival on location with necessary kinds and quantities of machinery. Insofar as fire fighting itself is concerned, two major benefits result from mechanization: (1) simplification of organization which permits fewer men to accomplish prompt and effective work; and (2) marked increase in work capacity and efficiency of individuals or groups.

Insofar as management is concerned, benefits of mechanization are realized in many ways; perhaps the most important of these are budgetary inasmuch as funds expended on machines, rather than payroll, last far into the future and may be used repeatedly throughout their working life. Smaller and more efficient organizations can be maintained to accomplish more work in the field than would be the case if they employed man power alone. Training programs are simplified, and these can be made more uniform for entire organizations of fire personnel. Due to these advantages, losses from forest fire in acreages and values have decreased greatly within the past decade. Moreover, it is certain that increases in effectiveness will continue into the future. It will be measured in terms of total areas burned in any given year and the average sizes of fires.

HOW FIRES ARE FOUGHT

Uncontrolled woods fire is a mobile thing. Its rate of spread is determined by many things, chief of which are moisture content of fuel, character and abundance of fuel, relative humidity, wind velocity, slope, air temperature, and exposure of fuel to drying influences. Theoretically, the area involved varies as the square of the time it has been burning. Owing to the fact that few fires spread equally in all directions, the actual rate of spread is somewhat less than this, and most fires assume elongated shapes determined by slope and wind influence. In periods of reduced hazard, rates of spread may be moderate and fires easily controlled; but when fuel is extremely dry as in spring periods, and when weather conditions are hazardous, rates of spread may be as high as a mile in five minutes. For short periods of time even faster rates of spread have been recorded.

In controlling running fire the immediate problem consists of stopping the moving perimeter, especially the head which moves at the fastest rate. Because of the behavior of fire, its movement in occupying land area has been compared to the action of military forces in battle, and the tactics employed to stop it are similar to those of a defending force. Men and equipment are moved in; positions are taken and maintained, and every effort is made to use all favorable circumstances

Fig. 1. Michigan double-bottomed sulky plow

Plow ready for line building. The trailer-hitch attachment has been removed and machine is ready to couple to drawbar of tractor. Full-floating carriage is shown, and winch control.

G. I. Stewart Supervisor, Michigan Forest Fire Experiment Station, Michigan Department of Conservation, Roseommon, Mich.

Contributed by the Wood Industries Division and presented at the Annual Meeting, New York, N. Y., November 26–December 1, 1950, of The American Society of Mechanical Engineers. Slightly condensed.

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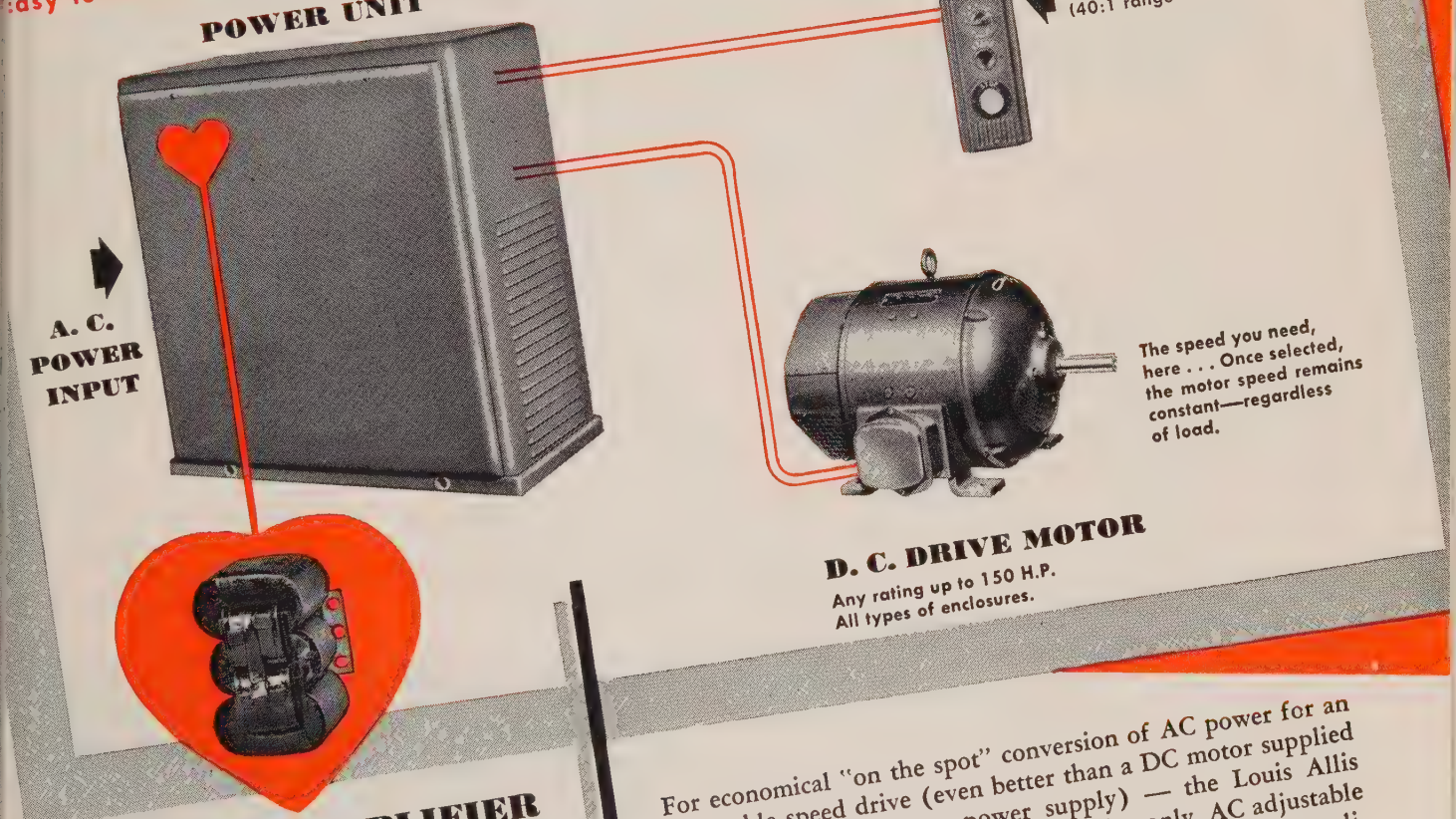
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Fig. 2. Type of fire line constructed by double-bottomed sulky plow

This barrier is typical of the kind of line used to control forest fire. It averages 7 feet in width. With proper organization of a ground crew severe fires can be stopped by such a fire line.

of natural barriers and terrain. In its movement, fire spreads through continuous fuel, and in stopping it every bit of flame along the moving edges must be extinguished. The amount of physical work required is enormous, especially since the time element is so important.

Effective methods can be made relatively simple if machinery is employed, and usually consist of constructing fire lines or barriers as close to burning edges as possible; or by subduing burning fuel with water. Many combinations of methods are useful, but for the most part, barriers must be built with heavy plows or other dirt-turning equipment, or fire must be stopped with tanker units and powerful pressure pumps. The difficulties lie not in method, but in the development and manufacture of suitable machinery capable of performing effective work under woods conditions. It is an engineering problem throughout.

MECHANIZATION IN FOREST-FIRE CONTROL

It is self-evident that mechanization in forest-fire control attempts to apply machine methods to all work phases involved. The problem is far more complicated than it would appear because most of the equipment required exists on the open market only in limited types and quantities. Furthermore, forest conditions vary greatly throughout the nation, and many kinds of equipment find only regional or local application. If types of machines remain more or less uniform, necessary differences in sizes still add to the complexity of the problem. Consequently, markets for such equipment are limited, which discourages commercial production. Most conservation agencies through sheer necessity have been compelled to invent, develop, and actually manufacture many classes of machines suitable for woods work.

At the present time, modern organizations own equipment in fleets that are dispersed throughout protection areas to the greatest strategical advantage. Such equipment falls into two general classifications, namely, (1) transportation equipment; (2) suppression equipment that performs the actual fire fighting. Considerable numbers of standard units are procured commercially. Specialized items that must be fitted to particular woods conditions require development from initial stages of design and invention to final production in quantity.

Transportation facilities consist of trucks in various sizes, semitrailer units, four-wheel-drive vehicles, pick-ups, cargo trailers, and cars. Fleets of these vehicles guarantee transportation for heavy fire-fighting apparatus and for personnel. Aircraft is in common use.

Suppression equipment involves a wide variety of machines, and in any one region or locality, woods conditions determine its composition. In general, it consists of tractors and bulldozers, heavy plows, graders, line builders, trenchers, and other classes of dirt-turning machinery, power pumps in many sizes, tanker trucks, trailers, including tanker units, well-sinking and well-pumping outfits, and varieties of specialized items. The distinguishing feature about it is lack of conformity to standard kinds of apparatus. Every suppression machine must be capable of operating in the woods, under severe conditions, and off the road; otherwise its usefulness is limited. All suppression machinery must incorporate features of design and construction which assure its assignment to woods operation. Much of it has been manufactured by conservation agencies in small shops with inadequate attention to correct engineering design. However, this was a stage of growth as mechanization was being developed. For a number of years experiment stations and research centers have been operated by some of the states and the Forest Service. Their efforts are devoted chiefly to equipment development and to its final manufacture.

APPLICATION OF ENGINEERING TECHNIQUES TO EQUIPMENT DEVELOPMENT

Throughout the nation programs are undertaken in various ways, but the methods employed by the Michigan Department of Conservation will exemplify application of engineering skills to the problems involved. Since 1930, the Michigan Forest Fire Experiment Station has been operated as a research center, and equipment development has been accorded first priority among all projects. The station has applied engineering methods for many years, and the results have been beneficial throughout the nation. Because of the magnitude

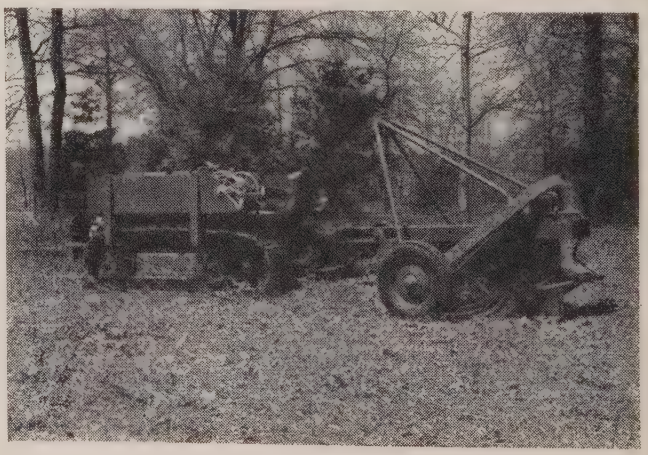
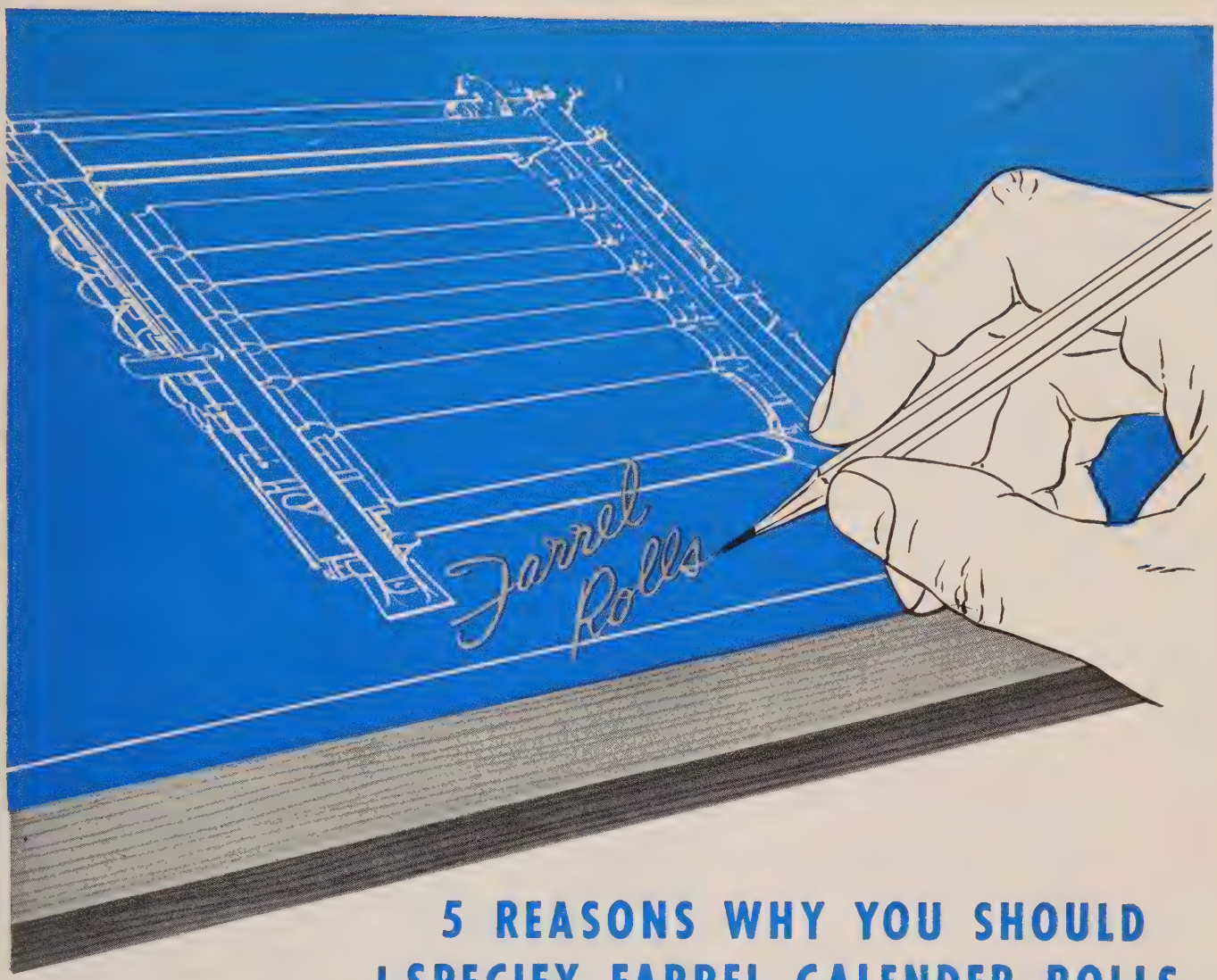


Fig. 3. Typical tractor-plow unit used in forest-fire control

Michigan double-bottomed sulky plow, attached to tractor in line building.



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of problems of mechanization, it is doubtful if results could be obtained efficiently and economically in any other way. The perfection of successful models of plowing machinery and subsequent manufacture might serve as an example of the ways in which all apparatus is developed and produced by the Experiment Station.

Analysis of Field Requirements—Plowing Machinery. Forest types—hence fuel types—vary greatly and woods conditions require full analysis before machine equipment can be adapted successfully to them. This is especially true of plowing units, which are used as line builders. It is their function to construct plowed barriers, free of all inflammable materials, where the moving edges of fire ultimately will be stopped. It is doubtful if any other class of machinery is expected to operate under more difficult circumstances, or to sustain more abuse. Machines must be designed to operate throughout a wide range of conditions, to embody adequate structural strength without excessive weight, and to assure the highest degree of mobility. Because of these requirements successful fire-control plows bear little resemblance to agricultural implements. Conditions under which plows are intended to function might be listed as follows for many millions of acres of forest land:

(a) Due to continued fire protection and normal growth, the density and size of timber restrict vehicular travel to crawler tractors. Plows suitable for line building must be adaptable to crawler tractors as draft machines. Most areas are characterized by mineral soil, often rocky.

(b) Roughness and steepness of terrain can be negotiated only by crawler tractors.

(c) Swamp lands intermingle with upland types and present conditions that limit vehicular operation to crawler tractors. Soils involved are usually muck or peat.

(d) Tough turf and heavy root mats characterize the kinds of ground conditions to be handled. Plowing depths range from a few inches in mineral soil, to 16 inches in root mats and in muck soils. To hold plow slices, total width of line should range from 5 to 7 feet.

(e) Ground cover will range from grass to heavy accumulations of shrubs and brush. In adapting plows to these conditions, it is imperative that maximum clearance be provided for in design, so that debris will move freely with the furrow slice and avoid clog-

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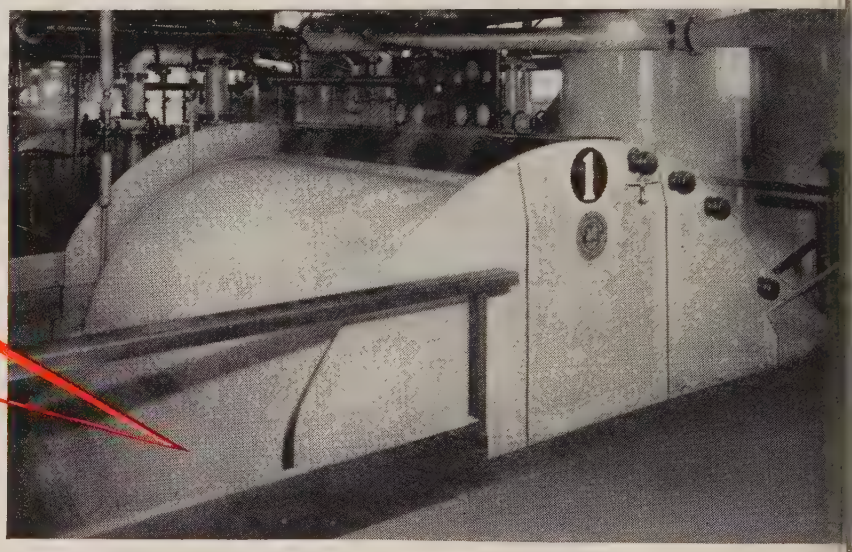

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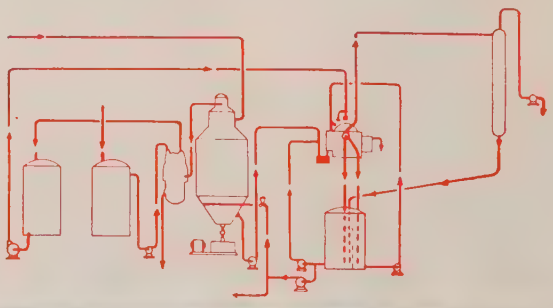

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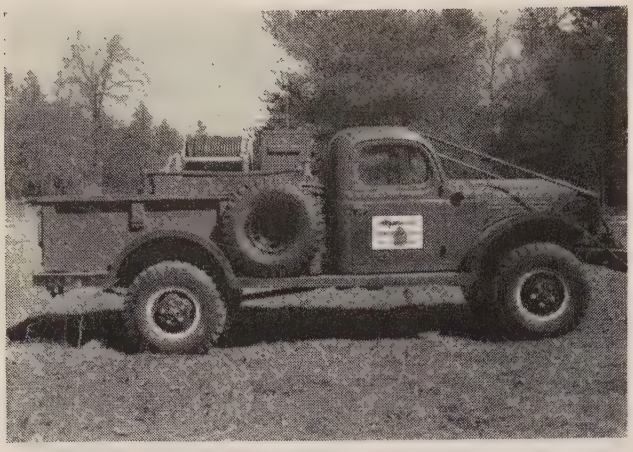

Fig. 4. Power wagon converted to tanker unit

This is a four-wheel-drive vehicle well adapted to woods travel. Body is completely armored. It is outfitted with a high-pressure pump, driven by power take-off, ejector tank refiller, live reel, complete tool equipment, and two-way radio-communication system. A kit of hand tools is included also.

ging within the plow structure. Windfallen timber will be encountered frequently.

(f) Timber will range in density from fairly open stands to dense plantations, or natural growth of similar-size classes. Diameters will range up to 24 inches with the majority of trees falling in size classes under 12 inches. Some stands will number 1500 trees per acre. To guarantee passage between trees, total width of plow should not exceed width of crawler tractor.

(g) Mineral soils will vary from sand to heavy clay. Rocks, boulders, heavy roots, and stumps will have to be handled by the plow. Total clearance in the plow base and other functional parts must be sufficient for the bottoms to uproot and turn under all trees which the tractor might ride down.

Tentative Plow Specifications as Determined by Analysis of Woods Conditions. In performing the functions of line building under circumstances listed, a successful plow would be expected to handle all of the soils encountered and to plow out of the line all trees and brush that might be ridden down by the draft tractor. The design of such an outfit is a detailed job in engineering. If undertaken with no previous experience in machine design, a number of experimental outfits would have to be produced before a satisfactory implement would evolve. At best, much research is needed and extensive field testing carried out before requirements would be met. Decision on tentative specifications must be made and might be arranged as follows:

(a) Insofar as possible commercial materials will be used in order to guarantee access to parts, and to avoid shop manufacture of special items.

(b) Minimum acceptable width of line averages 5 to 7 feet. Allowing for turned plow slices, this is best attained by use of a double-bottomed plow (reversed bottoms) with slices being thrown both ways from the center of the bases.

Plow bottoms of commercial make will be used. Right- and left-hand bases will assure reversed slices of required width. They should be classed as 18-inch bases, since a total of 72 inches of bare dirt would be exposed.

In order to handle all of the types of soils listed, the mold boards are to be high and long. Selection of proper plow bases is the most important single factor of design.

(c) Severity of ground conditions as indicated by rocks, heavy turf, root mats, heavy soils, and stumps, requires the use of stout and durable coulters. Need for two coulters is indicated; one of these mounted independent of the plow base will be a disk or rolling coulter; minimum diameter, 30 inches.

(d) Inasmuch as reversed bottoms are to be used, good design will permit setting them against a middle coulter. This middle coulter will be designed in several shapes of cutting edges; final shapes selected for use will permit adapting best forms to local conditions. Body of the coulter will be plate steel. Cutting edges will be formed by alloy bar, shaped and welded to the plate section. Final cutting edges will be made extremely sharp and hard, heat treated if necessary.

(e) Due to large amounts of surface debris and ground trash, that must be handled, ample clearance will be provided beneath the plow beam. A final height of 33 inches to top of beam will balance well with the size of rolling coulter selected.

Experience in line building with plows requires a beam length that will maintain a favorable ratio secured at the drawbar as compared to the height of beam. Total beam length of 8 feet is needed which will allow space for attaching all parts of the bases including braces, all parts of the drawbar, the headplate, and proper proportion of the standard.

(f) Due to preferred use of crawler tractors, drawbar capacities as high as 10,000 pounds must be provided for, although normal draft should not exceed 6000 pounds.

(g) With draft capacities known from Nebraska tests, stress calculations will determine final sizes, sections, and details of fabrication of all parts making up the final machine.

With the foregoing tentative specifications decided upon, features of design are completed on the drawing board.

Perfection of Pilot Model. When all stages of assembly are completed in plan, individual parts are detailed and precisely specified. Many of these must be made as castings, in steel, and malleable iron; patterns are developed for cast parts as required. Other parts are forged, turned, milled, or otherwise fabricated from solid stock, rolled sections, or tubing. As this process is carried out at the Experiment Station, manufacture of all parts and assembly of the entire plow are completed in its own shops. The final plow as developed by engineering analysis is illustrated in Fig. 1. Actually, this particular machine is the third model that has evolved in the manner explained. Improvements in design and construction followed assignment of machines in actual fire fighting. This type of plow has been in use in Michigan since 1936. Major dependence has been placed upon it for forest-fire control, and it is standard issue with the Michigan Department of Conservation. Eighty of these machines are in use at the present time.

Production in Quantity. After a machine of the type described proves acceptable to an organization, procurement in required number presents a problem, and this is

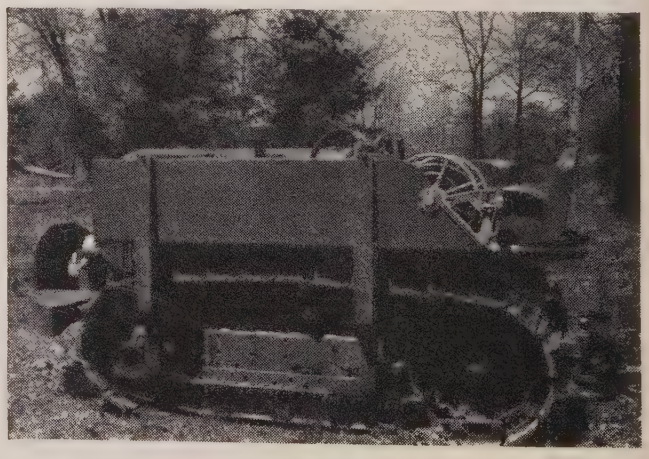

Fig. 5. Standard crawler tractor equipped as a fire-fighting machine

Used with heavy plows in constructing fire line. Commercial model of tractor has been converted to tanker unit by addition of water tanks and power pump, driven by a front power take-off.

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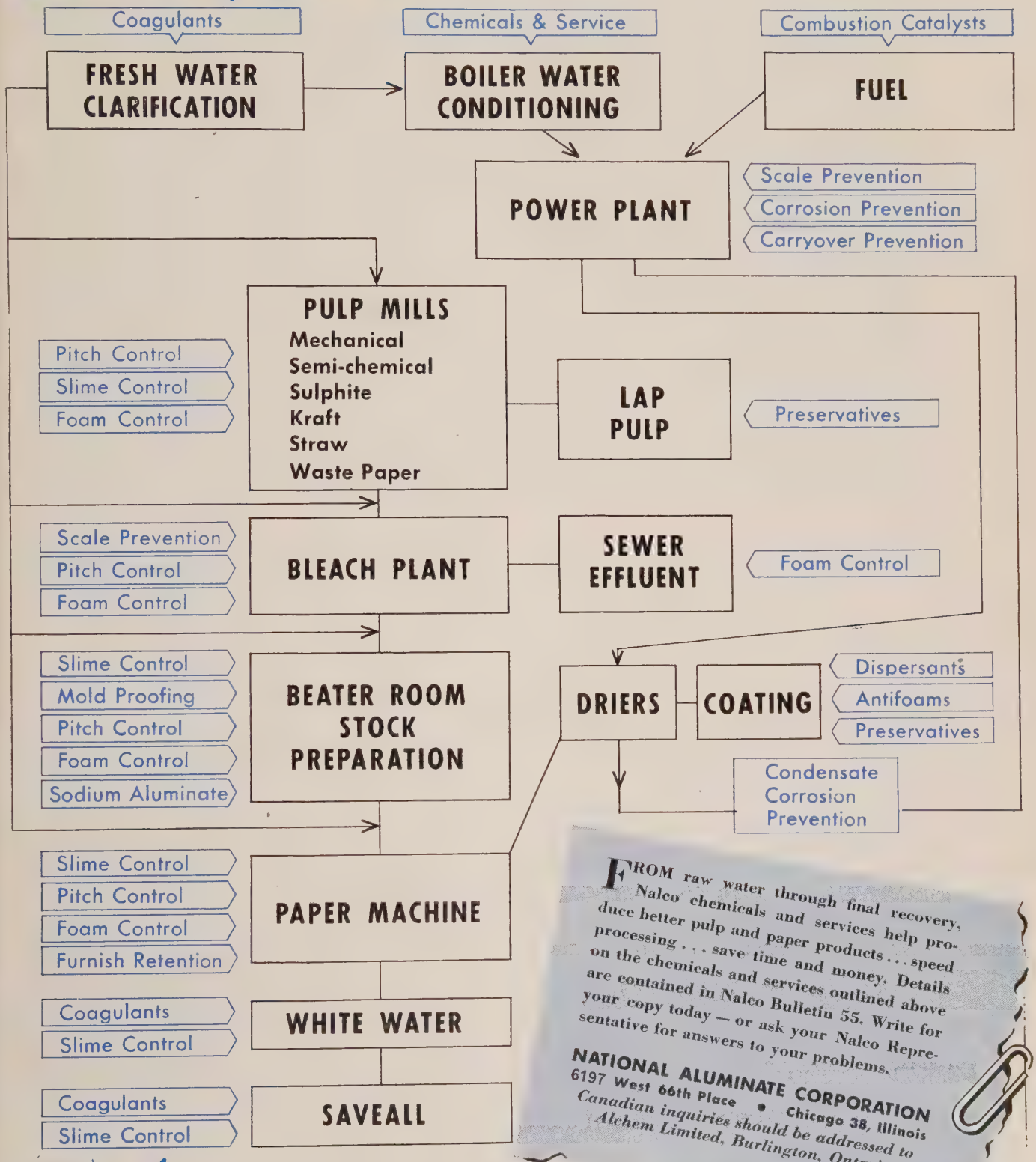

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likewise true of all other classes of machinery. Owing to limited markets, manufacturers are seldom interested in furnishing the modest numbers required at any one time. Because of this, manufacture is carried out in station shops. Manufacturing steps are similar to those in commercial plants. When finished, the units are retained for public use by the State of Michigan, or other agencies engaged in forest-fire control, but they are not sold as commercial items.

Mass-production methods are put into effect. Jigs, fixtures, templates, patterns, gages, welding positioners, and other necessary items are provided to govern production of all parts. Assembly lines are set up, and all phases of manufacture are completed. Each machine is finally identified by a metal plate listing model number, serial number, and unit number. Upon completion all machines are assigned to headquarters, or equipment depots to fulfill their purposes in fire control. During manufacture complete sets of prints and fixtures maintain adherence to specifications.

As a final step in issue, detailed instruction booklets are distributed and training periods are held with operators, to guarantee their familiarity with machines. This is especially necessary when improvements or model changes have been made.

CONTINUATION OF WORK IN FIELD TESTING AND MACHINE ANALYSIS

After pilot models are finished, or manufacturing schedules completed, further analyses from an engineering standpoint are desirable. These analyses are best made under field conditions similar to those under which equipment will be used.

It is essential, for instance, that data be assembled to determine draft requirements of plows in question, in terms of drawbar pull. Figures resulting from field measurements are reduced to graph records and tables. Results of field testing may be used to predict or check the adequacy of crawler tractors in terms of operating speeds and capacity, as compared to the drawbar requirements of the plows to be used with them.

In actual line building, operating speed is extremely important. If for some reason, a preferred type or model of tractor were overloaded, measured ratings of performance and drawbar requirements would indicate the fact; further work on plow design for purposes of assuring lighter draft might be required to match the machines properly. This would continue to be an engineering problem and lend itself to systematic analysis.

SCOPE OF EQUIPMENT DEVELOPMENT

In the foregoing the evolution of only one class of machine was discussed. The same procedure applies to any other kind of equipment. Insofar as the Michigan Department of Conservation is concerned, more than half of the outfits used in forest-fire control have been developed at the Experiment Station, and manufactured in its own shops. Fortunately, most motorized equipment can be used as standard commercial products; necessary conversions are usually simple. Tractors in large numbers and in several sizes are used as bulldozers and draft machines. Conversions are frequently made even on such basic machines as these in order to adapt them better to woods work or to increase their usefulness.

Outfits which have been developed and built in quantity are as follows:

1. Well-sinking and well-pumping units. Used for sinking shallow wells and pumping from them. Time required to place shallow wells into operation seldom exceeds 1 hour.
2. Breaker plows; walking types; used for rough operation in rocks and dense timber. Single-bottom plows.
3. Semitrailer units for heavy transport duty.
4. Trailer-mounted pumping equipment; heavy duty; used for long periods of operation on slash fires and burning muck; swamp fires. Used often in conjunction with well pumping.
5. Cargo trailers of a number of models. Used for general cargo duty in transporting fire equipment and supplies.
6. Fire cache trailers. Designed especially to store and carry hand equipment; also to carry portable pumping equipment and all accessories.
7. Michigan line builder; seven models in all. Designed as an intermediate machine for building barrier on lighter soils. Intended to be used as a small tractor, and capable of line building at moderate speeds; assigned to small crews.
8. Tilt-bed trailers for general transport; especially with tractors and line builders.
9. Tanker trucks; especially designed around four-wheel-drive units. The power wagon, shown in Fig. 4, is an example of this development, when converted to a tanker, and equipped with high-pressure pump, two-way radio, full accessory equipment, body completely armored.
10. Sulky plows in several models; mounted on pneumatic tires. Capable of line building under the severest woods conditions, and over a wide range of soil types. Adapted for use with many sizes of tractors. Suitable for fast fleet movement.
11. Michigan tractor-tanker; a conversion of standard crawler tractors in 30-hp. class (Fig. 5), to incorporate water tanks carried on the tractor, to furnish water supplies to power pump mounted on the tractor and driven by power take-off. Equipped with special features such as live reel, armored bumper, and accessory equipment.

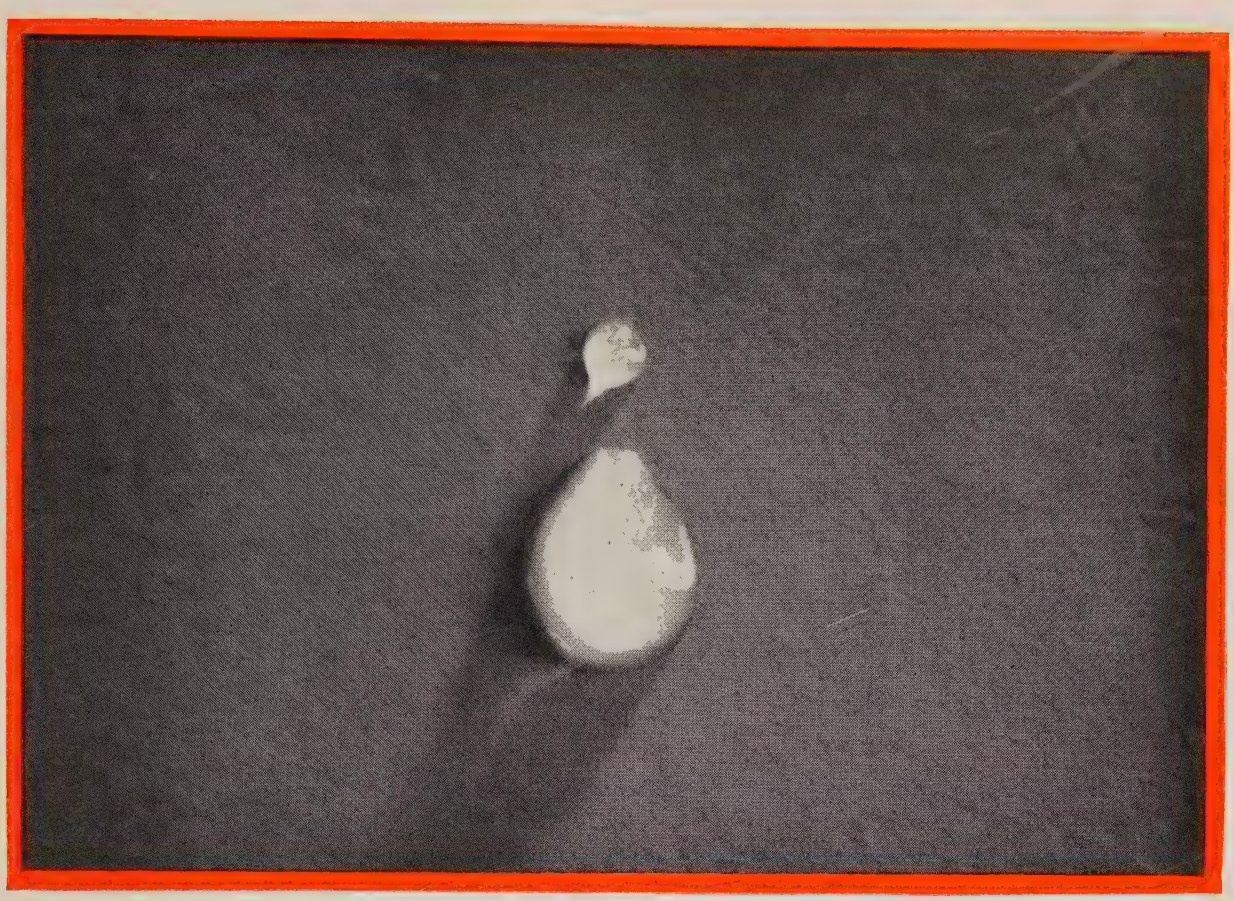
This machine is built in a second model in which the pump is self-contained and operated by independent gas engine. Both models are adapted to line plowing or to selective use with tanker trailers, which permits them to be used mainly as line builders, or as full mobile water-using outfits. Frequently used in team organization with the power-wagon tanker.

PRESENT-DAY FOREST CONDITIONS

The scope of equipment development is almost unlimited. At the present time much of the woodland of the United States is restocking a heavy second growth of timber, and forest conditions are changing rapidly. Density and size of timber stands are increasing, due to continued fire protection. It is likely that extensive and free operation of crawler tractors will be much restricted with the passing years, and that other kinds of machines will find their place as line builders. Major dependence will probably continue to be placed upon dirt-turning machinery, but it is to be expected that kinds of apparatus not yet perfected will be employed. Even though organizational planning has been well worked out new types of equipment will modify present procedures. The uses of chemicals have barely been investigated. Application of aircraft in actual suppression work is in its infancy. The helicopter faces a bright future, especially in wilderness country.

It is extremely important to clarify one point. The entire process of development of mechanized equipment is one of continual evolution. No machine is perfect at its inception; the uses to which machines are put in woods service are little short of brutal and imperfections are discovered. Improvements result from use and as a result all apparatus nears perfection with passage of time.

Reprinted from *Mechanical Engineering*, June, 1951.



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Alkaline Pulping Progress in 1950

SIDNEY D. WELLS

PROGRESS in pulping by the alkaline processes has extended each year since 1945 so that, in 1950, the extent of such progress exceeds any preceding year by a considerable margin. Technical improvements have been incorporated in the older units in conjunction with enlargement and integration, so that many of the older plants have been raised to a highly competitive position and the know-how gained from years of operation serves as a nucleus on which to build the enlarged organization. The grief and difficulties experienced by the pioneer mills established in the 1910's and 1920's have been largely avoided and the skepticism and doubts with which the soundness of the early adventures were regarded no longer exist. Many entirely new ventures have also been added. The adequacy of the supply of pulpwood was demonstrated in the 1920's by surveys by the Forest Service (*1*). More recent surveys have confirmed the soundness of the early prognostications. Skeptics in the established centers of pulp production have learned to rue their skepticism and the more progressive among them have placed their older plants in order and have done something about developing their existing supplies of wood, so that the picture for the future is much brighter than it was 30 years ago. The hardwoods, which were earlier considered of little value except as a source of soda pulp for use largely as a filler in book and magazine papers, are now being used as a complete source of pulp for many grades of paper; their use has improved many forests, so that they produce a more abundant yield of long-fibered coniferous trees for the established general-purpose pulps and for use as strengthening agents for furnishes of groundwood, waste papers, and other furnishes not adequate on their own account to make products of the specified characteristics.

Perry (*2*) has shown how lack of public interest and political pressures have allowed New York State to fall behind and have caused the pulp industry to become inadequate for local needs, even though well supplied with forest reserves and areas that should be amply adequate with reasonable management. Tinker (*3*) showed how the business of growing trees fits in with the general economy and the importance of public recognition of the fact. McClellan (*4*) indicated that everybody has a stake in our forests and should support effective forest management.

Lewis (*5*) reported that paper problems have not been neglected in current research. Tomlinson (*6*) reviewed recent trends in pulp and paper production from the research angle. Abele (*7*) discussed the philosophy of productivity in the minds of the management of American pulp and paper mills. West's Bibliography of Papermaking for the quinquennium 1946–50 has appeared (*8*). The *Paper Mill News* (*9*) gives a chronological review of the year 1949 to 1950. *Tappi* has published a condensation of preprints of the papers read at the Annual Meeting in February, 1951 (*10*). Progress in alkaline pulping during 1949 was published in October, 1950 (*11*). Tomlinson (*12*) discussed the recent trends in the manufacture of pulps as related to papermaking and Tinker (*13*) pointed out the importance of the South's pulp and paper production and the need for statecraft to encourage development and management of forests in the area to effectively utilize submarginal land and to provide a perpetual supply of raw material as a crop to insure the stability of one of the largest sources of livelihood in the region. Carruthers (*14*) recounted the life of Hugh Burgess, the pioneer manufacturer of wood pulps by alkaline processes in North America.

The annual presentation of wood pulp statistics has been issued for 1950 (*15*). Neubrech (*16*) has reviewed the pulp, paperboard, and paper production for 1949. Clauson (*17, 18*) reviewed market pulp for 1950 and commented on the lack of sulphite, including market pulp in general. Price and Pierce (*19*) reported that the consumption of unbleached kraft pulp declined slightly in 1950 but the amount of bleached pulp produced rose markedly, especially in the northern, southern, and western areas. Every (*20*) prophesied that the unbleached kraft paper production would hit the record in 1950. Ritchie (*21*) reported the pulp supply the largest on record. Ritchie and Bettendorf (*22*) prophesied that the 1950 production would slightly exceed that for 1948, a record year so far, even though imports from Europe have fallen off considerably. Dobrow (*23*) reports records being broken in paper production. *Pulp and Paper* published its North American review number in April (*24*) and the American Paper and Pulp Association (*25*) presented a survey of capacity for contemplated paper mills, giving 23,929,950 tons as the total for 1949, an increase of 540,950 over 1948, and an estimate of 24,254,000 tons for 1950 and of 24,311,405 tons for 1951. Meadows (*26*) gave the figures on textile fibers between 1892 and 1948, inclusive. *Papeterie* (*27*) commented on the high proportion of the world's supply of cellulose consumed in the United States and its effect upon the European paper industry. Scheye (*28*) pointed out the urgency in using modern methods to bring the supply of papermaking materials more nearly in line with the demand. Ziegler (*29*) described pulp and paper manufacture in North America, as observed by European eyes. *Papeterie* (*30*) discussed the influence of the American pulp market on the general situation. On the other hand, the world supply is viewed as being restored to normal (*31*). Bettendorf and Helme (*32*) gave a production of 9,069,600 tons of paperboard, Newberg and Bettendorf (*33*) presented the statistics of the paperboard industry, also (*33*) and *Fibre Containers* reported on the pulpwood, pulp, and paperboard industry in Canada (*34*). The annual directory of board mills in the United States and Canada made its appearance in December (*35*). Lewis (*36*) reported great acceleration in the production of pulp and paper. Hill (*37*) reported similarly. *Chemical Engineering* (*38*) forecast the trends during the next 10 years and more specifically (*39*) that 120 million dollars are being invested in various pulp and paper projects. Escarfail (*40*) noted his impressions as a French paper manufacturer of the paper industry in the United States. Fischer (*42*) discussed the difficulties ahead for German paper mills—especially, insufficient coal. Müller-Henneberg (*43*) reported that the per capita consumption of paper in Western Germany is now 28 kg. as compared with 36 kg. before the war.

EXPANSION IN THE UNITED STATES

The American Paper and Pulp Association (*44*) made a survey of new construction and contemplated construction for the years 1949 to 1952, inclusive. An output of 25,312,550 tons for 1952 seemed possible or an increase of 6% over 1949. Yowell (*45*) discussed the paper industry under the N.P.A. Laurola (*46*) surveyed the pulp and paper industries in the Southern States, with particular mention of the semichemical process. In the North, Great Northern increased production 40,000 tons yearly by revamping five of its existing paper machines (*47*). The Gould Paper Co. made extensive improvements (*48*). New York and Pennsylvania, Nekoosa-Edwards Paper Co., Minnesota and Ontario, and the Camp Manufacturing Co. substantially improved and increased their manufacturing facilities (*49–54*). The mill of the Riegel Carolina Corp. at Acme, N. C., is nearing completion (*55*). The long-established plant of Sonoco Products Co. at Hartsville has been enlarged and improved (*56*) and the recently established mill of the Macon Kraft Co. has continued

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Sponsored by the Alkaline Pulping Committee of the Technical Association of the Pulp and Paper Industry, Henry Vranian, Chairman. *Southern Pulp and Paper Manufacturer* finances the preparation of this report annually for TAPPI as a service to pulp, paper, and paperboard manufacturers.

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operation with many auxiliary features installed (*57–59*). The mill of the National Container Corp. at Jacksonville, Fla., has been improved and has doubled production (*60*). St. Regis Paper Co. has added mills at Jacksonville and Pensacola, Fla. (*61*). St. Joe Paper Co. has improved its plant at St. Joe, Fla., and added a converting plant in Texas (*62*). The Champion Paper and Fibre Co. has improved and enlarged its mill at Canton, N. C. (*63*) and the Mead Corp. has modernized its mill at Kingsport, Tenn., with special attention devoted to reducing stream pollution (*64, 65*). The Gulf States Paper Co. has improved its mill at Tuscaloosa, Ala., increased its production from 200 to 350 tons, increased bleaching facilities, and added to its capacity for bag manufacture (*66, 67*). The Coosa River Newsprint Mills has continued to give additional proof of the feasibility of southern pines for newsprint manufacture and the place for partly bleached kraft pulp as the strengthening fiber in this field (*68, 69*). The Natchez, Miss., plant of the International Paper Co. (*70–72*) has been in operation long enough to establish the soundness of the venture and the superiority of the sulphate process as applied to southern gums for producing dissolving pulps, superior for tire cord in many respects to many of the longer established pulps made by the sulphite process from northern softwoods. The Calcasieu Paper Co. at Elizabeth, La., has been completely modernized, and enlarged to a daily capacity of 200 tons and a paper bag capacity of 3,500,000 bags per day (*73–77*). The Crossett Paper Mills at Crossett, Ark., has been greatly enlarged and improved, and has added a new machine for making lightweight kraft papers. This mill was established in the 1930's with the help of a R.F.C. loan and with an established backlog of growing timber through reforestation, so that a never-ending supply of raw material is assured. This is an outstanding example of integration and buildup of know-how by a group not previously engaged in paper manufacture (*78–81*). A proposed newsprint mill was announced for Prescott, Ark., by the White Star Paper Co. (*82*).

Pringle and Lauer (*83*) discussed the pulp and papermaking prospects of Western Colorado. Idaho's first paper mill came into production at Lewiston with a capacity of 150 tons of kraft paper and board (*84–85*). Additional information regarding the Weyerhaeuser kraft board mill at Springfield, Ore., was given (*87*).

Masonite built a fiberboard mill at Ukiah, Calif. (*88*). Fibreboard products have built their first kraft mill in California at East Antioch (*89–92*).

EXPANSION IN OTHER COUNTRIES

Canadian mills have actively joined the march of progress with modernization and expansion programs and new building. Pouliot (*93*) gave a review of activity for 1950. The Canadian Pulp and Paper Association (*94*) presented its annual report. The *Pulp and Paper Magazine of Canada* published a list of 130 improvements, additions, etc., starting at the west and working eastward (*95*). The *Canadian Pulp and Paper Industry* pointed out how British Columbia is awakening to its potentialities (*96*). Manley (*97*) describes the growth of forest industries. Powell River, Ltd. has launched an extensive building program including wharves, additional power facilities, wood handling equipment, and improvements on paper machines (*98*). Pacific Mills, Ltd. has had a modernization and restoration program in progress for the past five years (*99*). The Canadian Western Lumber Co., in union with the Pacific Mills, Ltd., are contemplating a new newsprint mill at Duncan Bay (*100*). The new mill built by the H. R. MacMillan Export Co. at Naniamo is actively engaged in the production of 250 to 300 tons per day of unbleached and bleached pulp from Douglas-fir and other species (*101–108*). Further east, the pioneer Dryden Paper Co., Ltd. has been modernized and enlarged to more than double its former capacity (*109, 110*). The idle newsprint mill of the Abitibi Power and Paper Co., Ltd. at Sturgeon Falls, Ont., has been converted to a neutral sulphite semichemical pulp and corrugating paper mill making 100 tons of product per day and operating on limits once cut over for newsprint manufacture and now using species left behind from their original operation and second growth (*111*). The first mill to make fully bleached kraft in North America, the Brown Corp. at La Tuque, Que., has also been modernized and enlarged (*112*). In New Brunswick the Fraser Cos., Ltd. has built a new bleachery at Edmonston which will be supplied by a new 120-ton kraft mill at Newcastle (*113–116*).

The San Angel mills in Mexico have been modernized and expanded (*117, 118*). A new pulp and paper mill has been built in Costa Rica (*119*). Bowater's mill at Merseyside on the Manchester Ship Canal in Great Britain has been improved (*120*). The *Norsk Skogindustri* gives export statistics for forest products (*121*). Jarlsby discussed the Norwegian pulp and paper industry (*122, 123*). Sahlin (*124*) discussed the growth of the Swedish industry. Brax (*125*) described the new recovery unit at the Kotka sulphate mill of Enso-Gutzeit Oy. The *Svensk Papperstidn.* discussed the binder twine operation of Wahlbecks Fabriker (*126*). Much building has occurred in India (*127–129*), and the Government paper mill in Ceylon is being expanded to 4000 tons per year (*130*). Suitcase board manufacture has been initiated in South Africa (*131*) and the manufacture of paperboard in Australia was described (*132*).

In addition to plants using the more conventional pulping and papermaking methods, a great increase in plants making insulating building board and hardboard has occurred. Masonite's new plant at Uriah, Calif., has been built and is in production (*133*). King and Bender (*134*), Higgs (*135*), Linzell (*136*), Caughey (*137*), and Meiler (*138*) discussed processes used in the board field. Linzell (*139*) described the Insulite board mill at Kyrni and *Paper and Timber* (*140*) the new plant at Heinolan, Finland.

CONSUMPTION OF CHEMICALS

Taylor (*141*) described a method of making hydrogen sulphide for producing sodium sulphide. Skeen (*142, 143*) reported on the production of caustic soda and soda ash. Pulford (*144*) and *Chemical Industries* (*145*) described the reclamation of sodium sulphate from natural deposits of Glauber's salt in Saskatchewan. *Chemical Engineering* (*146*) gave figures on the production of chlorine. Amroc, Inc. (*147*) discussed how a small industry can make its own chlorine. Johnson and Cherniavsky (*148*) disclosed a modification of the Deacon process, using fluidizing techniques. Taylor (*149*) discussed the products that the paper industry needs from chemical industries. *Chemical and Engineering News* (*150*) presented the figures for production of chlorine for 1950. MacGonagle (*150a*) discussed the use of sodium silicate and *Chemical Engineering* (*151*) gave the consumption figures on alum.

WOODS USED

Consciousness of the need for growing wood as a crop on land submarginal for other crops is gradually penetrating men's minds and united effort by groups of workers who have long been aware of the situation is taking form. The Forest Products Research Society (*152*) is one such group which recently reported on wood. The Food and Agriculture Organization of the United Nations is another (*153*). The *World's Paper Trade Review* (*154*) recently discussed the utilization of forest resources. Fischer (*155*) discussed the European supply. Demeritt (*156*) gave a summary of production in New England. MacAdam (*157*) discussed hardwood utilization in New Hampshire and Smith (*158*) from the poorer sites in New Jersey. Amidon (*159*) and Cunningham and the Forest Survey Staff (*160*) wrote on the status of forestry and the forest resources survey in the Lake States and

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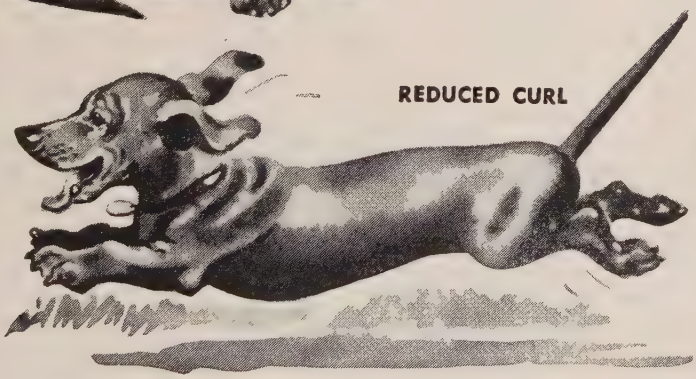

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the constant improvement of the pulpwood supply. McCaffrey (*161*) discussed the problems imposed by the pulpwood industry in the 11 Southern States and the measures taken to meet them. Gragg (*162*) specified the steps taken in the same territory. Malsberger (*163*) pointed out the importance of the pulpwood industry in the economic life of South Carolina. Carpenter (*164*) reported from 0.43 to 0.46 cord of chippable waste available from saw mills per 1000 board feet of lumber sawn.

Helversen (*165*) discussed the materials handling practices on the West Coast. Tinney (*166*) commented on the rapid regeneration of forests in the West. Bassett (*167*) called attention to the sale of crown timber in British Columbia. Gilmore (*168*) advocated that Canada's forests should be privately owned. Delisle (*169*) discussed forest education and technical guidance for small woodland owners in Quebec. McGraw (*170*) treated the growth of balsam fir in Newfoundland, and Martin (*171*) described mechanical loading, transportation, and discharge of pulpwood by barge.

For a long time pulpwood was harvested at considerable expense and stored for needlessly long periods at landings or in yards where decay and insect attack set in while losses of unknown extent occurred before the wood was sent to the woodroom and to the digesters. In the Southern States, the losses were undoubtedly greater than in the North on account of climatic differences, and many southern operators were under the illusion that the fact that the bark fell off on its way to and through the woodroom was an advantage which they had that was not shared by northern operators. The term "bug barking" came into use and the toll taken by the bugs and fungi for their service was not known. At one southern mill, a survey of the toll was made in 1917 and it was found that, for much of the wood reaching the digesters, losses in wood substance as high as 25% had occurred with substantial reduction in the strength properties of the pulp (*172*). The manager who took over the mill soon realized the seriousness of the situation and so organized the wood handling that minimum delay occurred between felling of the tree and conversion to pulp. His example was followed by others, so that now the whole industry avoids much of these losses. Keaton and Gillespie (*173*) reported on practice and losses 32 years later. In northern mills, Pascoe and Scheffer (*174*) reported that pulpwood deterioration could be severe and good practice must be followed to avoid it. Glennie and Schwartz (*175*) reviewed the literature on the subject.

Edwardes (*176*) discussed woodroom losses and their control. Redden (*177*) described the woodroom. Fenton (*178*) considered light portable chippers for chipping in the woods. Kanto (*179*) disclosed methods for sorting chips. Pascoe (*180*) proposed a photographic method for scaling pulpwood on a freight car or truck. Worthington and Twerdal (*181*) discussed the contents of a piled cord of 8-foot wood.

Silversides (*182*) described the Westvaco 20,000-acre experimental forest in South Carolina. Rottier (*183*) described the use of the Athens disk in stimulating natural reproduction of aspen near Amasa, Mich. Bonner (*184*) discussed regeneration of spruce and jackpine after cutting. Johnson (*185*) showed how silviculture is applied in the operations of the Mersey River Paper Co. Rottier (*186*) discussed green harvest at less cost by the M & O Paper Co., and Fixmer (*187*) gave a progress report on the thinning of jackpine in the Mosinee industrial forest. Smith (*188*) maintained that forestry can pay, Gillett (*189*) showed how the volume of the tree utilized can be raised from 30 to 70%, Freese (*190*) pointed out how growth was doubled by release from overtopping hardwoods, and Connaughton (*191*) showed how various items in forest management can benefit efficient operation.

Greeley (*192*) presented a rational approach to forestry practice on private lands. Monroy (*193*) discussed the economic possibilities of small-scale forestry combinates. Koroleff (*194*) discussed the farm woodlot as an important source of pulpwood, and Holt (*195*) described the tree planting machine. Silversides (*196*) presented the effects of logging on growth and stand and the lag of practice that will be experienced until mature and overripe stands have been utilized. Paul (*197*) suggested means for improvement of quality of second-growth Douglas-fir stands. The Western Pine Association (*198*) reported on the properties, uses, and grades of white fir in the western pine region. *Pulp & Paper* (*199*) described how the Southern Kraft Division of the International Paper Co. obtains its annual supply of 3,500,000 cords of pulpwood.

Stewart (*200*) reviewed the results from training choppers in pulpwood operations and Stamm (*201*) compared hand with power falling and bucking in the West.

The Canadian Pulp and Paper Association (*202*) discussed the mechanical hauling at Heron Bay, Ont., in October, 1950. Horncastle (*203*) described use of the self-loading sloop. Harris (*204*) described the Uyssen skyline crane used in the Gaspé Peninsula. Anker-Rasch (*205*) discussed transportation problems. McNally (*206*) discussed semitrailer operations by the Brown Corp. Simmons (*207*) enumerated new developments in harvesting sawlogs and McCall (*208*) considered cable yarding, mechanical hauling, and power saws. Mørch (*209*) discussed the problems of forest engineers. Williscroft (*210*) reported on the use of the Caterpiller D.W. 10-wheel diesel tractor hauling sleighs, Irvin (*211*) on off-road transportation, Gunter (*212*) on truck hauling, Kirkpatrick (*213*) on the Bailey bridge, the *Paper Industry* (*214*) on the new G.M. and O. pulpwood car.

Glidden (*215*) described the floating log flume, LeMay (*216*) bundle skidding at Marathon, Stoeckler (*217*) pulpwood preparation in Scandinavia, and *Norsk Skogindustri* (*218*) the forest industry in Sweden. Hall (*219*) discussed different patterns of integration in forest utilization, Ruden (*220*) the breeding of forest trees in Denmark and Sweden, and Cohen (*221*) the integrated wood-using industries in Australia and New Zealand.

Grosjean (*222*) listed substances in the bark of deciduous trees subject to fungicidal activity, Fuller, Harston, and Chester (*223*) discussed the utilization of bark waste as mulch and a soil conditioner and Ögland (*224*) considered bark as a raw material or a waste. Rindsland (*225*) described bark utilization at Mando, and Klem (*226*) reviewed chemical barking. Leaf (*227*) described a new stream barker for pulpwood, *Pulp & Paper* (*228*) the Hansel ring-type barker, and the Sandy Hill Iron and Brass Works (*229*) the Peppy Peeler. *Pulp & Paper* (*230*) described the Allis-Chalmers portable and stream barker, Wilén (*231*) the use of bark as a fuel, Hillbom (*232*) the barking of small timber and hardwoods and Schwartz (*233*) the Squire bark crusher.

Power (*234*) disclosed an outfeeding mechanism for portable barkers, Swift and Dobson (*235*) a hydraulic barker with self-sealing means, and Piispanen (*236*) a log debarking device.

Numerous species are presently being pulped in considerable quantities that were not acceptable a few years back. Jensen (*237*) discussed the use of birch veneer waste. Navarre and others (*238*) debated the more extended use of chestnut, eucalyptus, poplars, aspen, and birch. Sawada (*239*) described the semichemical pulping of *Cinnamonium camphana*. Semichemical pulping has greatly extended the use of hardwoods for corrugating paper and paperboard and printing papers in combination with mechanical pulps.

Clapperton (*240*) presented a paper before the Institute of Engineers of Scotland on wood as a material for making paper. Lewis (*241*) reported on the significant chemical components of western hemlock, Douglas-fir, western red-cedar, loblolly pine, and black spruce. Mitchell and Ritter (*242*) determined the galactan content of western larch. Cook and Smith (*243*) and Benson (*244*) considered the growth and yield of red pine in New York and Minnesota. Murto and Itkonen (*245*) discussed southern pine and its use for kraft pulp. Hughes and Mackney (*246*) studied the density and

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moisture content of *Pinus radiata* in New Zealand, and Lindstedt (*247*) the extractives in *Pinus aristata*. Proctor (*248*) and Kurth and Ratnam (*249*) reported on the waxes and tannin and the products derived from the destructive distillation of Douglas-fir bark. Andersson and Straud (*250*) compared Canadian aspen with Swedish aspen and gray poplar; the Canadian species were superior. Jensen (*251, 252*) discussed the derivatives from the suberin of birch (*Betula verrucosa*) and the use of its wood for pulping. Bland (*253*) and Foster, Schwerin, and Cohen (*254*) reported on the chemistry of eucalypt wood and the presence of uronic acid ester in young wood. Turnbull (*255*) presented the taxonomy and Meller (*256*) discussed the effect of prehydrolysis in kraft pulping of eucalypts. Holmgren, Vay, Rubi, and Capo (*257*) reported on the sulphate pulping and bleaching of *Eucalyptus saligna*, and Bisset and Dadswell (*258*) on the fiber length of pulps from *Eucalyptus regnans*.

Rogers, Calderwood, and Beebe (*259*) reported on the tannin content of Florida scrub oak bark and Harvin, Hills, Rothrock, and Nolan (*260*) on the pulping characteristics of the wood residue. Fixmer (*261*) discussed the mechanical elimination of scrub oak in stands of more desirable species. Sproull, Methvin, and Hard (*262*) reported on the pulping of old railroad crossties. Rys (*263*) described the manufacture of kraft pulps from Parana pine and stated that many species of hardwoods are also available. A proposed groundwood mill in the upper Amazon valley in Peru is to operate on cetico (*264*). Tortorelli (*265*) discussed Argentina's subtropical stands for pulp and paper manufacture and especially *Araucaria augustifolia*. Le Cacheux and Pétéri (*266*) recommended a modification of present views to coincide with technological advance to bring about the utilization of hardwood species in tropical forests.

AGRICULTURAL RESIDUES AND GRASSES

The manual of grasses of the United States by Hitchcock and revised by Chase has appeared (*267*). Doane (*268*) commented on the fact that pulps solely from fibrous agricultural residues are usually uneconomical on account of the natural adaptability to printing of papers containing principally groundwood and the low cost of the product. Porphyre (*269*) discussed the merits of long and short fibers and the relationship of diameter to length. Fisher (*270*) suggested more annual plants for papermaking, especially cereal straws cornstalks, *Arundo donax*, esparto, reeds, bamboo, and other grasses. Becker (*270a, 273*) and others (*271, 272*) described the developments of the Cellulose Development Corp. (chlorine process). Eskridge (*274*) patented the alkaline digestion of cottonseed hulls. Cooper (*275*) discussed the use of hemp hurds and sorghum bagasse. Chujo (*276*) reinvestigated kozo. Raitt's work on bamboo has appeared in an American edition (*277*). Gray (*278*) gave an account of its use for pulp and paper. Aggarwala (*279*) discussed its characteristics and the degree of polymerization of the cellulose derived therefrom. Heck (*280*) gave the properties of some bamboos cultivated in the Western Hemisphere, and White (*281*) has prepared a circular on its culture and utilization in Puerto Rico. The mechanical handling of bamboo from river to digester is explained by Trost (*282*). Bhargava, Kasbekar, and Patel (*283*) and Tyabji (*284*) discussed the utilization of palmyra palms. Ducé (*285*) and Tabb (*286*) stated that straw pulping and utilization may be a bane or boon depending upon how well the plant is designed and adapted to its use and the determination with which the problem is attacked and carried out. Ullman and Bean (*287*) quoted from Piette's book published in 1838, which contains samples of paper made from straw and other materials. Odrich (*288*) pointed to straw pulp as a way out of the raw material shortages. Renaud (*289*) compared several pulping processes. Franck and Aronovsky (*290*) described straw pulping practice in France and the use of the Hydrapulper with a large rotor in the United States, and Krancher and Price (*291*) reported their experience with a Hydrapulper at Noblesville, Ind. Herman (*292*) discussed the performance of the roll-type fiber press on straw. Mainguet (*293*) disclosed a process using nitric acid. Aronovsky (*294*) reported on the Terre Haute meeting of the TAPPI Agricultural Residue Committee on Nov. 7 and 8, 1949.

Considerable prominence has been attained in studies on the composition and utilization for paper and board of bagasse in various parts of the world. Almeida (*295*) reported on the composition of the fiber and ash. Baldwin (*296*) discussed the use of wood pulp and bagasse in a Peru mill. Vasquez (*297, 298*) described the manufacture of paper, board, cellulose and yeast. Bhargava (*299*) covered the manufacture of wrapping and bag paper. Becker (*300*) described the operation at Oriental Negros in the Philippines and at Benoni, South Africa (cf. *301*). The *World's Paper Trade Review* covered results in general (*302*). The *Chemurgic Digest* reported on a run of paper used for newsprint in Massachusetts. Although not having the typical characteristics of newsprint, it could undoubtedly be improved by using a proportion of deinked papers in the furnish (*303*). Aries (*304*) described the Cuban pulp and paper industry and suggested that, with the enormous quantity of bagasse available, manufacture of paper pulp for export may eventually develop.

Considerable interest is manifest in *Lespedeza sericea* (*305–307*). Esparto has returned to its place as a papermaking material and is receiving attention (*308–310*). Chittenden and Coomber (*311, 312*) discussed how trash from banana culture might be used. The uses and economics of ramie have also been considered (*313*). Porphyre (*314*) gives data on the collection and cooking of the reed (*Phragmites communis*), and Patettor, Kumayay, Vay, Rubi, and Capo (*315*) report on *Cana picanilla* (*Guada paraguayana*). Chittenden and Coomber (*316*) gave conclusions on the pulping of castor stems from Ceylon. Sun (*317*) discussed the fibrous raw materials in Formosa. Porter (*318*) described the modernization of Maizewood's insulation board plant which successfully used cornstalks for many years and now can operate on flax shive, willow, and almost any fibrous material that can be obtained advantageously. Besser, Montonna, and Smith (*319*) discussed the chemical delignification of flax straw. Lathrop, Naffziger, and Stivers (*320*) reported on the replacement of veneer by strawboard in wirebound shipping containers, and Lathrop, Naffziger, and Williamson (*321*) on the manufacture on the farm of insulating board from straw. Aronovsky (*322*) estimated the world supply of cereal straw and its use for paper, and Sutcliffe and Aronovsky (*323*) discussed improved processes using sodium-base agents for pulping straw.

COOKING PROCEDURES AND DIGESTER FACILITIES

Probably the controlling factor affecting the expansion of pulping facilities at the present time is the increase in cost of equipment and buildings. Where $20,000 per ton of daily production was considered adequate in the 1910's, the cost now is over $65,000. *Chemical Engineering* gave a résumé on the subject (*324*). Tomlinson and Swartz (*325*) have contributed the chapter on alkaline process pulps in the revised edition of pulp and paper manufacture by the Joint Committee on Vocational Education. Werner (*326*) and Keith (*327*) contributed articles on soda pulping for the University of Maine series; Beckler (*328*) and Carlin (*329*) wrote on kraft pulping. Sawyer, Holzer, and McGlothlin (*330*) and Sawyer, Beals, and Neubauer (*331*) presented flow diagrams and a description of kraft pulp and paper manufacture at the Camas Mill of the Crown Zellerbach Corp. Zevallos (*332*) discussed the physico-chemical mechanism of alkaline digestion of wood, and Tarkkonen (*333*) disclosed methods of procedure. Gray (*334*) patented a process for producing wood pulp of uniform extractive composition and Bradbury (*335*)

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discussed the effect of partial acidification on pulp screening and subsequent operations. Bartunek (*336*) recited experience with new wood pulps for rayon; the superiority of dissolving pulps from hardwoods is indicated (*337*). Sloman (*338*) discussed countercurrent pulping, Sucksdorff (*339*), continuous stock preparation, and Richter (*340*), the recovery of heat.

Benson (*341*) discussed the use of ammonia base. Corrosion of digesters with changes in steel composition, cooking conditions, introduction of new species, etc., is causing considerable concern. Collins, Baisch, and Vander Velden (*342*) described lining digesters in the field with Inconel. Flynn (*343*) published a report on the subject. Johnson (*344*) reported an experience at the Union Bag and Paper Corp. Teeple (*345*) reported for the Digester Corrosion Subcommittee of TAPPI. Collins (*346*) published an annotated bibliography on digester corrosion with 36 references. Funk and Wyche (*347*) discussed stainless clad steel for digesters. White (*348*) reported the failure of a pulp mill digester, and Johnson and Gibson (*349*) that of a stainless steel lining of pulp mill digesters. Teeple (*350*) discussed the use of nickel-containing alloys, von Essen (*351*) corrosion problems in general in sulphate mills, and Mott (*352*) stainless steel castings, valves, and fittings. A general discussion of materials of construction for pulp and paper mills has appeared (*353*, *354*). Morseth and Haner (*355*) described a chip-filling device, Briggs (*356*) disclosed wood pulp digestion, and de la Rosa (*357*) a modification of his continuous digester.

Semichemical pulping has made great progress. West (*358*) has published an annotated bibliography. Wells (*359*) contributed Chapter VII of Volume II of pulp and paper manufacture. Perry (*360*) described semichemical pulping for the lecture series for the University of Maine. The industry has grown from less than 40 tons per day in 1925 to over 2115 tons per day in 1950 (*361*). Eguchi and Yoshikawa (*362*) and also Marpillero (*363*) have presented a study of the process. The expansion at Filer City to 120 tons per day has been described as a "revolt" (*364*). Porter (*365*) has described the new plant at Green Bay (cf. *366*). Murtfeldt (*367*) described the use of semichemical neutral sulphite pulps from aspen for book paper, and Parsons and Lausman (*368*) discussed the bleaching operation and its results. Fries (*369*) presented studies and runs on the production of aspen semichemical pulp for glassine. McEwen (*370*) disclosed a method of bleaching semichemical pulps. Murtfeldt (*371*) reported corrosion as it occurred in a semichemical pulp mill. Runkel (*372*) described semichemical pulps, and Schepp (*373*) has presented his observations as a German technologist on an E.C.A. visit. Sapp (*374*) described the manufacture and refining of high-yield semikraft and neutral sulphite semichemical pulps. Saunders (*375*) and Limerick and Callaghan (*376*) discussed high-yield kraft pulps. Keller (*377*) reported on the effect of bark in the semichemical pulping of slash pine aspen and hickory, and Brown and McGovern (*378*) the use of dilute caustic soda with aspen chips at temperatures below 100°C. Edge (*379*) discussed the selection of a pulper and Thweatt (*380*) considered equipment for wallboard manufacture. DePan (*381*) described a small plant for insulation and hardboard manufacture. Vincent (*382*) disclosed apparatus for refining fibrous materials, Gloersen and Richter (*383*) a process and apparatus for the continuous after-treatment of disintegrated fibrous material, and Renard (*384*) described the Cyclone refiner. Bowillé (*385*) discussed cavitation in refiners. Textor and Eberhardt (*386*) described revolving disk mills in straw pulp production. Sprout, Waldron and Co. (*387*, *388*) discussed semichemical pulping and refining and their experience at the Maizewood Insulation Co. Goodwin (*389*) described the Asplund defibrators, *Pulp & Paper* (*390*) the place for the Chemipulper, and Asplund and disk refiners in semichemical pulping, and Paper and Industrial Appliances, Inc. (*391*) the use of the Asplund and Beveridge-Kehoe reaction chamber. The Bristol Co. considered the instrumentation of the Chemipulper (*392*). Sutherland (*393*) suggested more pulp through high yield. Jansson (*394*) described the continuous heat treatment and humidification of hard fiberboards at Säynätsalo, and Sears (*395*) the variables affecting woodwaste molding. Englerth (396) discussed the deterioration of fiberboards by molds, and Farber (397) the alkaline sulphite digestion of hardwoods at atmospheric pressure. Libby and O'Neil (*399*) the manufacture of chemigroundwood pulp from hardwoods, and Wirpsa and Libby (*400*) the penetration of neutral sulphite cooking liquor into yellow birchwood.

FOAM, TALL OIL, TURPENTINE RECOVERY, AND FOAM CONTROL

West (*401*) has recently published an annotated bibliography on tall oil with 932 references. Jakobson (*402*) reviewed the literature (he covers much the same ground as West) and Lassenius (*403*) gave statistical data on by-products. Last (*404*) discussed tall oil, Harva (*405*) its properties, and Kajanne (*406*) and Sarkanen and Kahila (*407*) its composition. Kahila (*408*) discussed the tall oil content in sulphate black liquor, and Jensen (*409*) its chromatographic analysis. Young and Calleton (*410*) disclosed the spray drying of crude kraft soap skimmings and Kalman (*411*) patented a method for separating the rosin acids. Rosher (*412*) and Gates and Radeker (*413*) disclosed methods of esterification to assist in the separation of the fatty acids constituents from the rosin acids and Dunlap, Hassel, and Maxwell (*414*) reported on studies on the subject. Johnson, Mark, and Jelling (*415*) received a patent on a surface-active composition by changing the amines present to amides, Hasselstrom (*416*) discloses the removal of sodium lignocerate, Christenson and Gloyer (*417*) the recovery of sterols and fatty acids, and Gayer (*418*) the recovery of dehydroabietic acid. Pollak and Johnston (*419*) proposed a method for the purification of abietic acid separated from tall oil. Koonce and Perry (*420*) patented a method for separating fatty acids and rosin acids.

Johanson (*421*) claimed that rosin acids are excellent for preparing paper size by the Delthirna system but are not satisfactory for Bewoid size preparation. Johanson and Lindahl (*422*) stated that they are better where complete saponification is practiced. von Mikusch (*423*) discussed the possibilities and limitations of tall oil in paints and varnishes and Carrick (*424*) considered tall oil as a new source for vegetable oil in paint. Alexander Benemelis, and Crecelius (*425*) stated that tall oil and rosin derivatives can be used in oils for paint up to 50% without affecting performance. Cowan, Ault, and Teeter (*426*) discussed the polymerization of tall oil to form rubberlike products.

Bernstein (*427*) discussed tall oil as a potential source for drying oils and Mathews (*428*) included it among the newer drying oils. Spitzer and Ryan (*429*) disclosed a process for improving the drying qualities. Kaberg and Harris (*430*) disclosed emulsifiable oil concentrates of biological toxicants, and Davis and Barth (*431*) patented a sulphurized tall oil. The Tall Oil Association (*432*) discussed driers and metallic soaps and Unkefer (*433*) disclosed the preparation of metallic soaps. Gayer (*434*) patented the use of ammonia to recover abietic acid. Rust (*435*) was granted a patent for making of tall oil esters and Mueller, Eness, and McSweeney (*436*) pointed out that catalysts do not assist within practical temperatures. Snell and Reich (*437*) stated that detergency and foaming properties of tall oil soaps are approximately in the order of the oleic acid content. Beretvás (*438*) disclosed protective coatings made of calcium naphthenate, zinc naphthenate, and tall oil lead soap.

Metallurgists are manifesting considerable interest in the use of tall oil for flotation. Herkenhoff (*439–441*) disclosed its use for the pretreatment and flotation of iron ores, and Booth and Herkenhoff (*442*) claimed the sulphonation of tall oil for the beneficiation of iron ores. Gieseke

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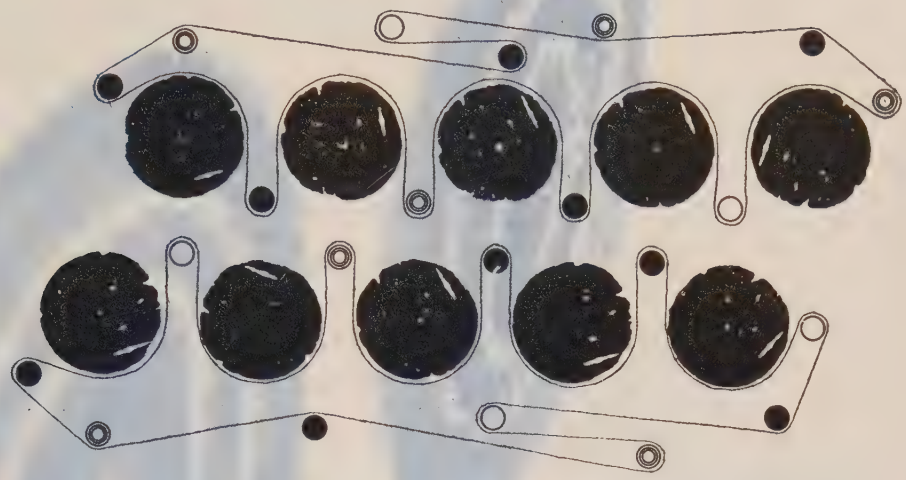

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(*443*) and DeVaney (*444*) patented the use of tall oil for flotation, and Moyer (*445*) for the beneficiation of metallic oxide ores. McMurray (*446*), McMurray and Moyer (*447*), and Gieseke (*448, 449*) suggested its use in apatite-ilmenite, phosphatic titanium-oxide mixtures, Florida pebble phosphate ores, and tungsten ore flotation.

Gabrielson (*450*) disclosed the use of tall oil for an air-entrained mortar. The Tall Oil Association (*451*) discussed the place of tall oil in core binders. Gutkin (*452*) covered the same subject, and Vincent (*453*) disclosed a sand mold composition.

Dawson (*454*) and Dyke and Self (*455*) disclosed its use as drilling fluids. Enkvist and Kahila (*456*) and Walden (*457*) discussed manufacture of lubricating and emulsifiable oil from tall oil. McCoy (*458*) disclosed a slowly setting bituminous emulsion, and Glick (*459*) patented a polymerizable styrene-tall oil modified polyester composition for impregnating porous castings and the like.

Bruun, Hafnor, and Sörenson (*460*) discussed the possible relation of the sulphur compounds in sulphate turpentine to the eczema suffered by many who come in contact with it. Hasselstrom, Balmer, Kennedy, and Coles (*461*) discussed the synthesis of terpene carboxy esters from sulphate turpentine. Fisher, Goldblatt, Kniel, and Snyder (*462*) discussed the role of peroxides from turpentine in the cold polymerization of GR-S.

ANALYTICAL AND FUNDAMENTAL

Marshall and Sankey (*463*) disclosed methods for pulping lignocellulose material and simultaneously producing oxidation products therefrom. Schuerch (*464*) reported experiments on the fractionation of isolated wood lignins. Van Beckum (*465*) disclosed a process for producing dehydroperillic acid. Clare and Sherwood (*466*) discussed the separation of organic constituents of black liquor. Richtzenhain (*467*) described the oxidative degradation of methylated lignin preparations. Marshall and Sankey (*467a*) disclosed the production of vanillin. Aries (*468*) and Dunn, Seiberlich, and Eppelheimer (*469*) discussed lignin as a fertilizer and soil builder. Russell (*470*) wrote on pitch, pentosans, and paper, and Gavelin (*471*) on pitch troubles in paper mills. Elmendorf (*472*) described four new products, Heritage and Van Beckum (*473*) the processing of lignocellulosic material, and Heritage (*474*) processes for the production of cellulose fibers. Werner (*475*) discussed binders' board. Roseveare, Waller, and Wilson (*476*) described the properties and structure of regenerated cellulose, Ullman (*477*) the prehydrolysis of cotton, Schur and Lewis (*478*) the role of pulp viscosity and degree of polymerization in papermaking, the Mark (*479*) the four types of fiber-to-fiber bonding. In a recent address, Roseveare further brought out the outstanding properties of hardwood sulphate pulps for dissolving purposes for tire cord. Wallerstein and Alba (*480*) reported the removal and recovery of proteins by water-soluble lignin. Kullgren (*480a*) discussed the ion exchange properties of kraft pulp.

Jayme (*481*) discussed the biological structure of unbleached wood pulps. Jayme and Köppen (*482*) considered the structural and chemical differences between sulphite and sulphate pulps, Haywood (483) the effect of variations in size and shape of fibers, and Holzer (*484*) the relation between wood and pulp properties.

Williamson (*485*) answered questions on beating, Tolvi (*486*) discussed the beating of kraft pulp, and Scribner, Shaw, O'Leary, and Missimer (*487*) the employment of resin bonding of the fibers in paper formation. Wurz (*488*) described the absorptivity of paper halfstuffs. Haug (*489*) discussed the improvement in newsprint realized by the use of highly refined tailings in the furnish. Gall (*490*) suggested the production of bituminous kraft as a profitable means for extending the usefulness of old paper machines and rejected clothing.

Sack (*491*) presented the determination of sodium sulphate, sulphite, thiosulphite, sulphide, polysulphide, oxide, and carbonate in the presence of one another. Richter, Scarth, and Bernhardt (*492*) explained the use of flame spectrophotometry in alkaline pulp mill control. Jayme and Mohrberg (*493*) reported a rapid method for determining the cellulose content of poplar woods. Assailly (*494*) suggested a simple control method for measuring the delignification of paper pulps by use of the polarizing microscope and Herzberg's stain. McPherson (*495*) disclosed (as a patent) a foam separator, and Ross (*496*) gave a general discussion of the inhibition of foaming.

RECOVERY OPERATION AND EQUIPMENT

Badger and Lindsay (*497*) have published their review of progress in evaporation for 1950. It is becoming very much a standardized unit process with considerable thought devoted to maintenance of clean heating surfaces. Thermal compression evaporators are receiving considerable attention. Regestad (*498*) reviewed the literature on the subject. Skaperdas (*499*) treated heat transfer in its various applications. Lockman (*500*) and Ramén (*501*) have patented heat-exchange apparatus. The Kestner Evaporator and Engineering Co. (*502*) described Calder-Fox scrubbers of the impingement type. Walther (*503*) described the chemical cleaning of black liquor evaporators. Edling (*504*) reported the heat balance for three types of pulp mills. Roberts (*505*) discussed the evolution of modern recovery units for the University of Maine lectures. Cubberly (*506*) pointed out the almost limitless possibilities for waste heat recovery. Dean (*507*) discussed the recovery of waste heat in pulp and paper mills. The Foster Wheeler Corp. (*508*) described heat recovery at the St. Regis Paper Mills at Pensacola and Cantonment, Fla. The Australians put a new wrinkle in black liquor recovery (*509*). Wykman (*510*) described a new recovery unit, Gadret (*511*) disclosed a process for the treatment of waste liquors, and Dalin (*512*) a method for avoiding incrustation on heat exchange members. Westbrook (*513*) described the recovery operations in southern pulp mills and pointed out the advantage of large operations, Willins (*514*) considered the prevailing practice in soda and sulphate mills in the north, and Reid (*515*) reported on soda recovery and losses. Betts (*516*) patented a method of recovering heat and suspended particles from the flue gases; Fogman (*517*) described the use and control of electric precipitation, and Danser (*518*) pointed out the possible use of ultrasonics with a new type of entrainment separator. Hamm (*519, 520*) disclosed a superheater for chemical recovery units. The high-temperature, high-pressure power plant of the Union Bag and Paper Corp. is described (*521*), as is the cleaning of boilers according to the Hutter process (*522*). Bergström and Trobeck (*523*) disclosed a process for utilizing waste liquors and Trobeck (*524*) described the B. T. system for soda and heat recovery in sulphate pulp mills. Brashares (*525*) discussed refractory practice in kraft pulp mills.

Rich (*526*) discussed the dewatering and washing of pulp. von Hildebrandt (*527*) has taken out a patent for a process of separating spent cooking liquor from pulp. Fröhlich (*528*) described a continuous diffuser. Perkins (*529*) discussed the application and operation of a rotary gravity filter. Zimmerman and Vranian (*530*) discussed pressure washing, and Burling and Rich (*531*) patented a method and apparatus for chemical treatment of pulp. Chandler (*532*) described instrumentation as applied to brown stock washing, and Lipscomb (*533*) disclosed an apparatus for diluting and washing pulp suspensions.

Ahlfors (*534*) described the screen known by his name, which is made in the United States by the Oliver United Filters. This screen allows the stock to flow from below the plates upward and should give cleaner stock. The Lindblad (*535*) screen has also been described. Dings magnetic separator has received considerable comment (*536*).

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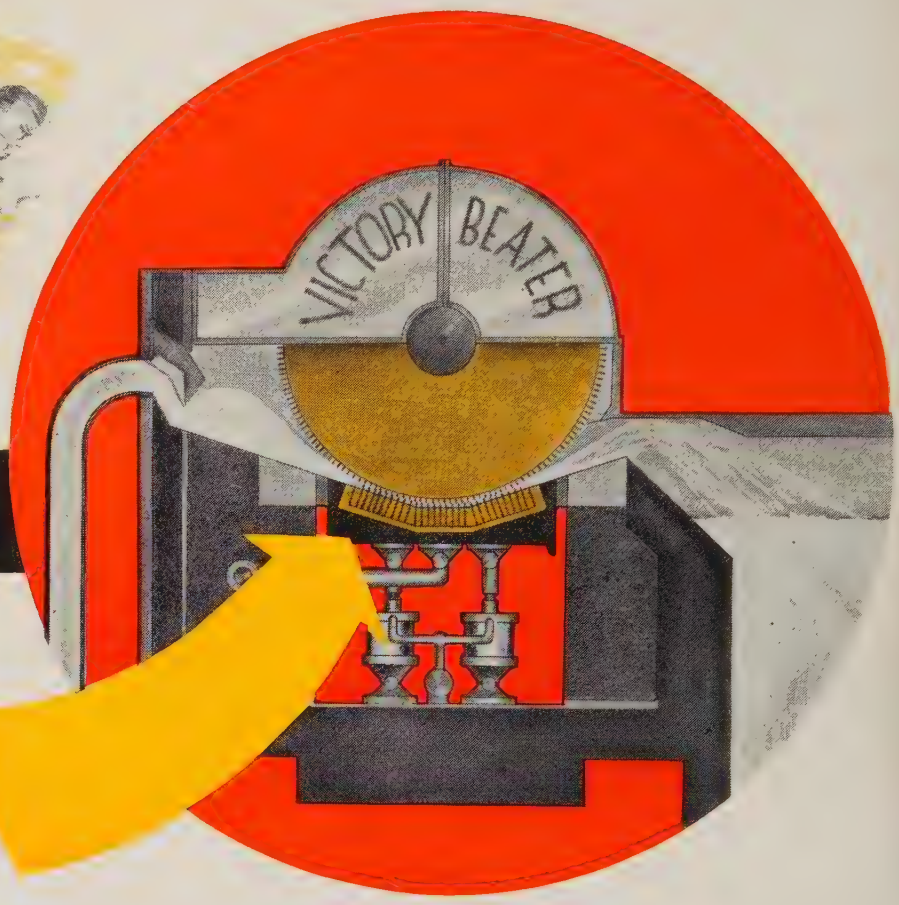

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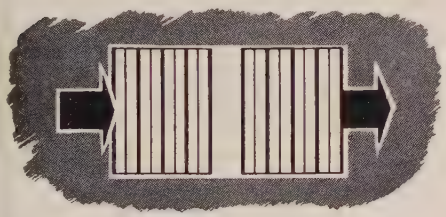

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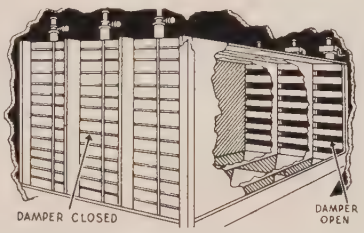

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and Cowles and Kelly (*538*) described the development and construction of a side-drive pulper. Rushton, Costich, and Everett (*539*) show the power characteristics of mixing propellers. A translation has appeared of the work of Brecht and Heller (*540*) on pipe friction losses of paper stock suspensions. Doyle (*541*) described the Haug Kollermill. Schilling (*542*) disclosed a metering device for removing rejects from Vortrap setups.

Infilco Inc. (*543*) discussed accelerated chemical causticization, Roberts and Harper (*544*) the effect of degree of causticization on the settling rate of white liquors, and the Bird Machine Co. (*545*) on the filtration of lime mud.

Gibbs (*546–551*) discussed the operation, design, thermodynamics, and economics of rotary lime kilns. Krishnaswamy (*552*) discussed the regeneration of lime, Martin-Löf (*553*) the reburning of lime sludge as compared with limestone, and Gee (*554*) modern methods of lime production; Finland's first kiln for burning lime sludge is described (*555*).

EFFLUENTS TO STREAM AND ATMOSPHERE

Extensive studies and plant-scale installations have been made or are in the course of construction in a wide range of paper and board mills. Brookover (*556*) discussed the paper industry and stream pollution. The Canadian Pulp and Paper Association (*557*) published a bibliographic review of stream pollution, and Doudoroff and Katz (*558*) a review of the literature on the toxicity of industrial wastes and their components to fish. Crawford (*559*) discussed mill operations from the stream pollution point of view, and Doutt (*560*) the effective work by the industry. Kirchen (*561*) and Demoulin (*562*) showed the relationship between increased re-use of white water and the reduction in losses through continuous control. Van Horn, Anderson, and Katz (*563*) discussed the effect of kraft mill waste on fish life.

Winget (*564*) enumerated methods available for pollution abatement. Erganian and Hargleroad (*565*) described research on strawboard mill effluents, Lardieri (*566*) the organic constituents, Bloodgood, Kinnaman, and Coleman (*567*) the reduction possible through cleaning the straw before cooking, and Bloodgood (*568*) the development of a method for treatment through pilot plant studies. Knack (*569*) described the waste deposal plant for a combined board and strawboard mill, Erspamer (*570*) a plant for a book paper mill, and Savage (*571*) an evaluation of the problems for several types of mills. Rudolfs and co-workers (*572*) gave a review of the literature on toxic substances affecting sewage treatment, streams, and B.O.D. determinations and the Washington State Pollution Control Commission (*573*) published the minimum requirements for control of fiber loss, wood waste, etc.; the O.C.O. water system for re-use of white water has been described (*574*); Grushko (*575*) considered waste liquors from hydrolytic plants and sanitary protection of reservoirs. Morgan (*576*) discussed the determination of the type and degree of treatment needed. Gehm and Bloodgood (*577*) the problem in each separate mill, Keyes (*578*) wastes in pulp and paper mills, and Kohlins and Demarest (*579*) waste utilization and disposal systems. Matagrin (*580*) discussed the chemical treatment of white waters in the American paper industry; the *World's Paper Trade Review* (*581*) the water purification plant of the Rutheglen mill of the Clyde Paper Co., and Kline (*582*) reported on samplers suitable for industrial water surveys. Mohlman (*583*) commented on waste disposal as a factor in plant location, and Murdock (*584*) on industrial water.

New York State (*585*) has proposed a scheme for the classification of streams and pollution controls, Lawrance (*586*) discussed the addition of sodium nitrate to the Androscoggin River, Horton (*587*) considered the pollution capacity of the Wabash River, LeBosquet and Weibel (*588*) the industrial wastes of the Ohio River, and Kittrell (*589*) the pulp and paper mill wastes in the Tennessee Valley. von Essen (*590*) discussed the pollution problems of sulphate pulp mills, Moggio and Gehm (*591*) the biological treatment of kraft mill wastes, Barnes, Moggio, and Colmer (*592*) reported studies on the biological action in stored kraft mill effluent, and Murdock (*593*) suggested the substitution of the kraft for the sulphite process as a means of greatly reducing the pollutional load from pulp manufacture.

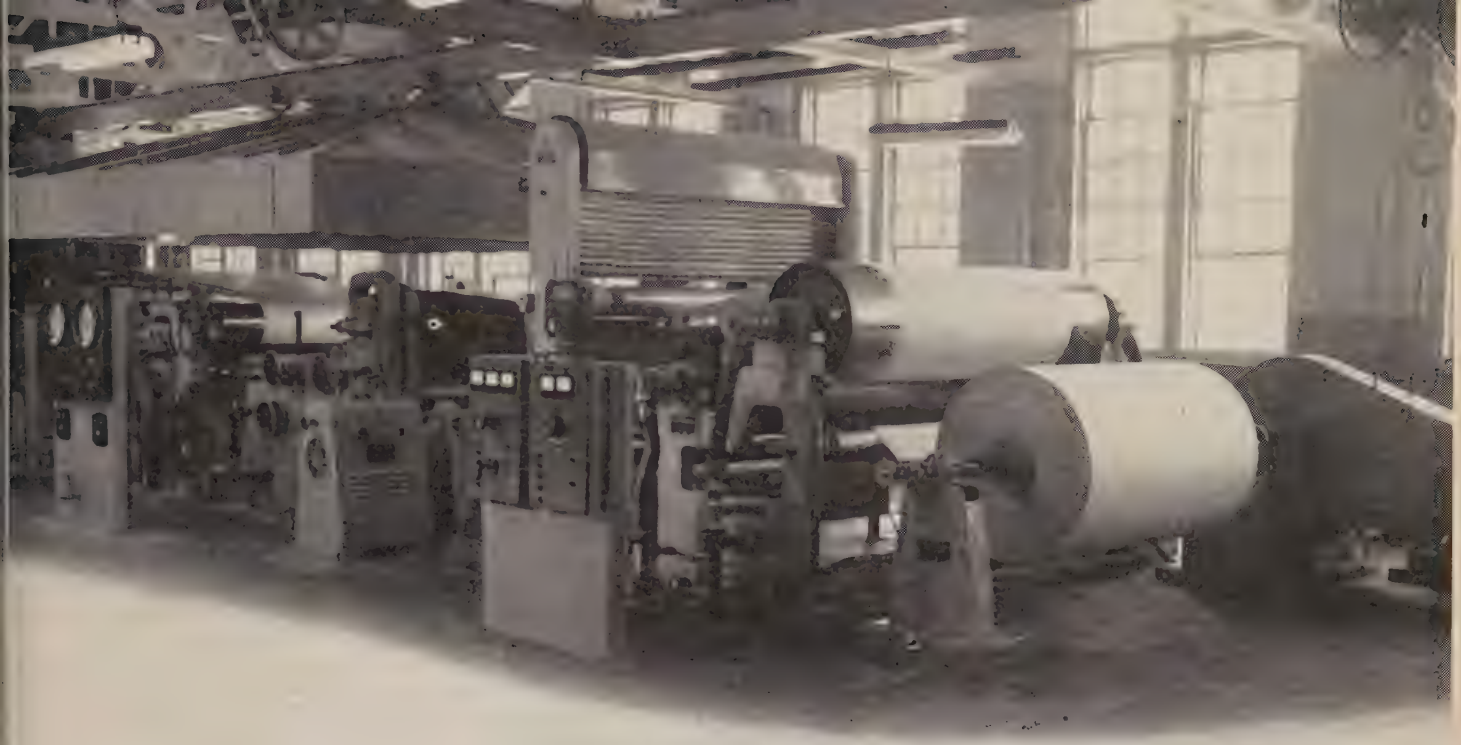
Hartmann (*594*) reviewed the legal regulations on air pollution. Katz and Cole (*595*) described the recovery of sulphur compounds from atmospheric contaminants. Bozza and Colombo (*596*) reported studies on the elimination of odors from a sulphate mill in Italy. Reid (*597*) covered the same subject for a mill at Maryvale, Australia. Allen (*598*) reported on the Bergstrom tower for the removal of toxic compounds, and Collins (*599*) on the oxidation of black liquors for the elimination of hydrogen sulphide and the recovery of sulphur dioxide. Hisey (*600*) reported on the successful reduction of odor at the mill of the South African Pulp and Paper Industries, Ltd. near Johannesburg, South Africa. Reed and Updegraff (*601*) described the removal of hydrogen sulphide from industrial gases.

PURIFICATION AND BLEACHING

Kraft (*602*) contributed the chapter on sulphate and sulphite pulp bleaching in Volume I of Pulp and Paper Manufacture. Lal (*603*) discussed the bleaching of pulp, and Mehta (*604*) considered multistage bleaching. Parsons (*605*) contributed the lecture on the chlorine bleaching of paper pulp for the University of Maine lecture series. Phillips (*606*) described the preparation of chlorine for paper pulp, and Murotani (*607*) a two-stage soda-chlorine pulping and purification process. The *Pulp and Paper Magazine of Canada* (*608*) describes La Tuque's new bleach plant, Dennis (*609*) the bleaching of eucalypt soda pulp, Chadeyron (*610*) the bleaching of maritime pine, and Corey (*611*) the bleaching of Bauer pulp from woodwaste. Darbyshire (*612*) disclosed a method for the precipitation of calcium hypochlorite.

Considerable progress has been made in the peroxide bleaching of groundwood and semichemical pulps. The Buffalo Electro-Chemical Co. (*613*) showed how small pulp mill operators can now bleach at high efficiency. The Gould Paper Co. (*614*) has equipped its mill to use sodium peroxide. Jones (*615*) reported on his work to ascertain the effects of sodium peroxide bleaching on the components of eastern spruce groundwood.

Chlorine dioxide is receiving much attention as regards processes for its manufacture and its use in bleaching. Lundberg (*616*) described its manufacture by the Persson process and the use (*617*) of chlorine dioxide for bleaching. MacLeod (*618, 619*) discussed the industrial application of sodium chlorine dioxide. Cunningham and Pretka (*620*) and Rapson and Wayman (*621*) patented methods for producing sodium chlorite and chlorine dioxide. Day and Hoos (*622*) and Day and Fenn (*623*) disclosed treatment with and production of sodium chlorite with hypochlorite and from sodium chlorate and hydrochloric acid. Haller (*624*) disclosed a process for manufacture of and Hutchinson (*625, 626*) for the generation of chlorine dioxide. Aston (*627*) disclosed the repression of chlorite and chlorine dioxide generation from acidified chlorite solutions. Samuelson and Hartler (*628*) discussed the effect of chlorine dioxide and chlorite bleaching on the copper number, hot alkali solubility, and carboxyl number of sulphite cellulose. Holst (*629*) discussed the electrochemical and thermodynamic analysis of the production of sodium chlorite and disclosed (*630*) the production of chlorine dioxide from sodium chlorite. Casciani and Storin (*631*) discussed the use of chlorine dioxide and sodium peroxide, and Stone and Matarese (*632*) considered the bleaching of kraft pulp with mixtures of sodium chlorite and chlorine. Takamatsu, Hoshino, and Homma (*633*) described pulping with sodium chlorite, and Sevón and Sundman (*634*) proposed a method for preparing chlorine dioxide gas.



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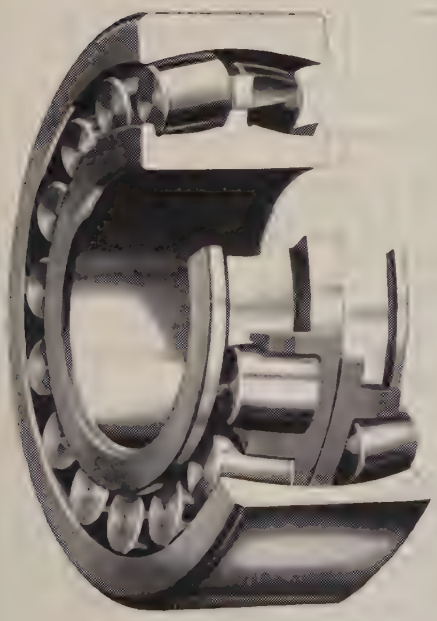

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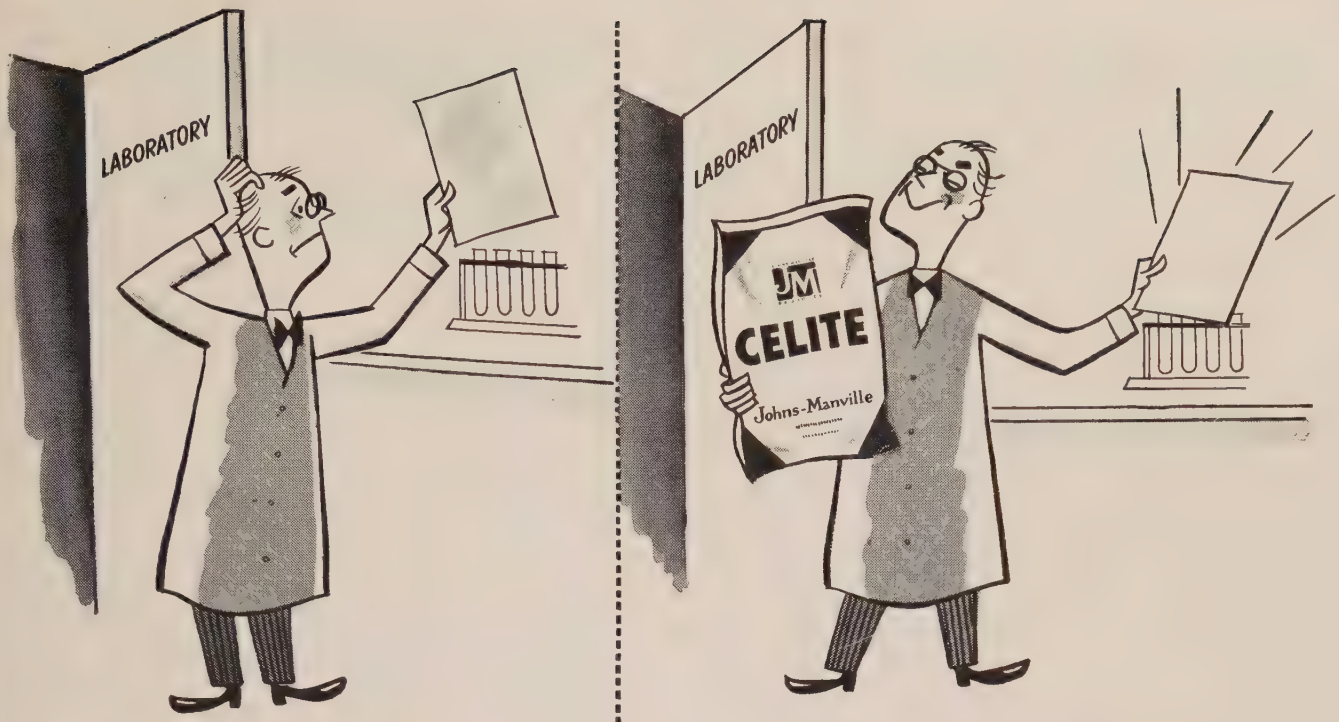

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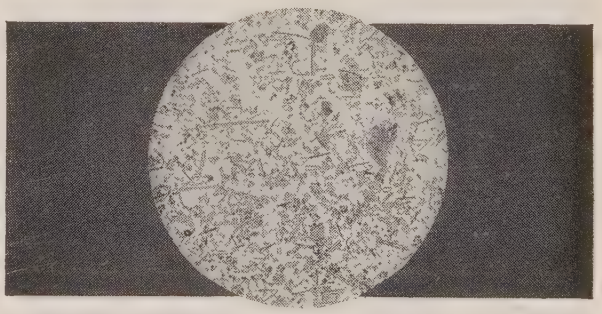

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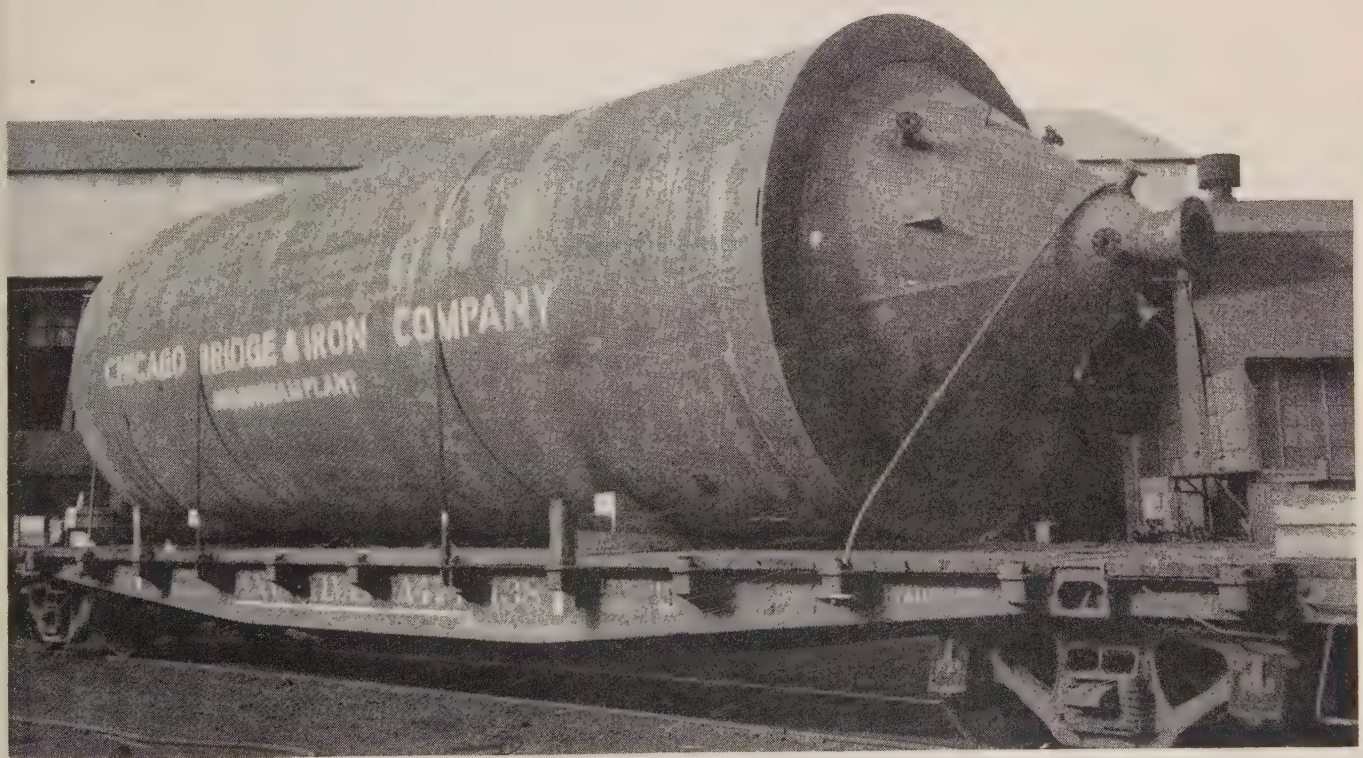

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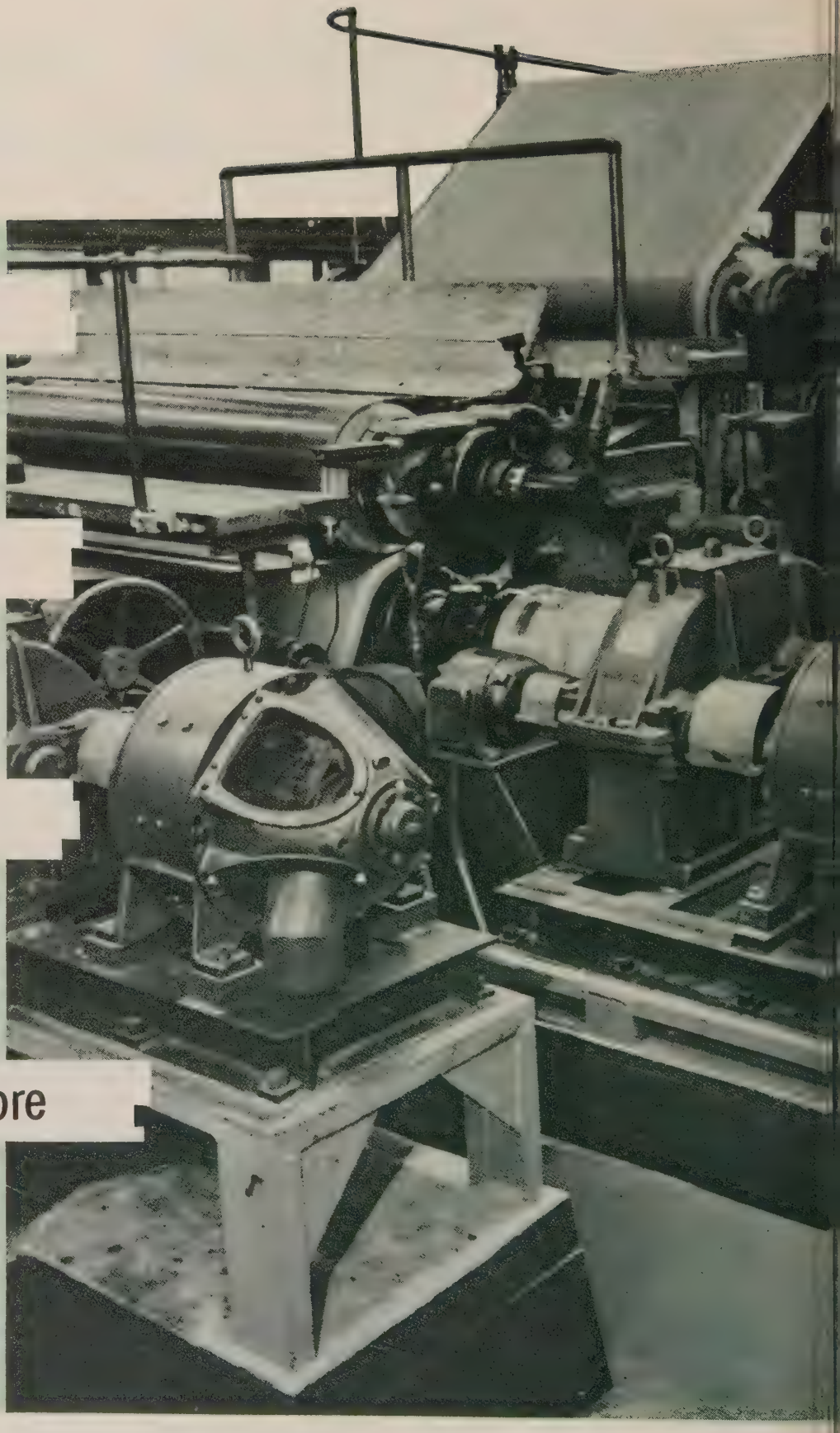

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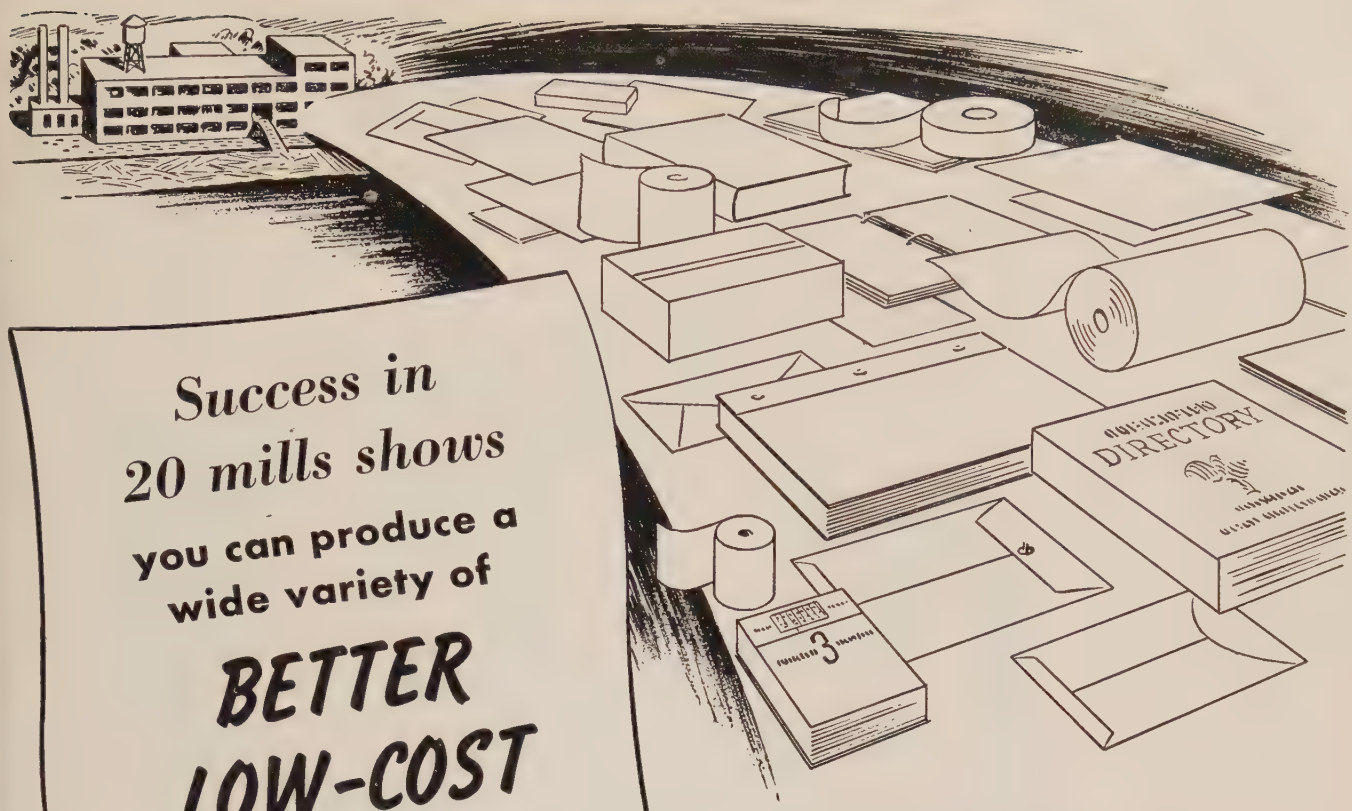

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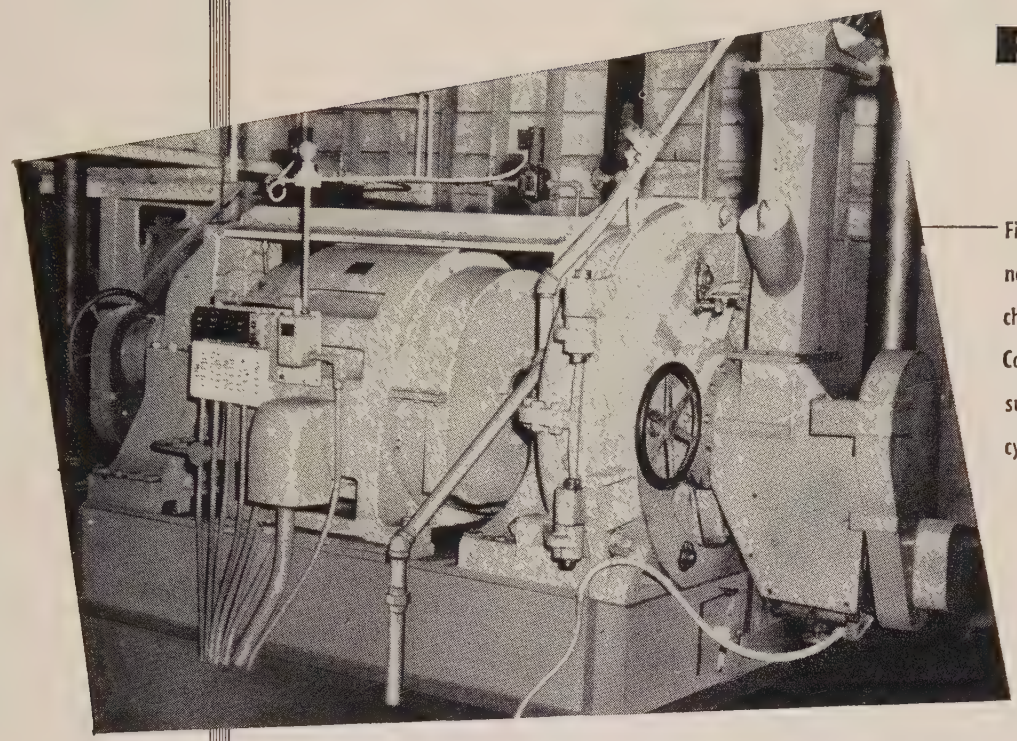

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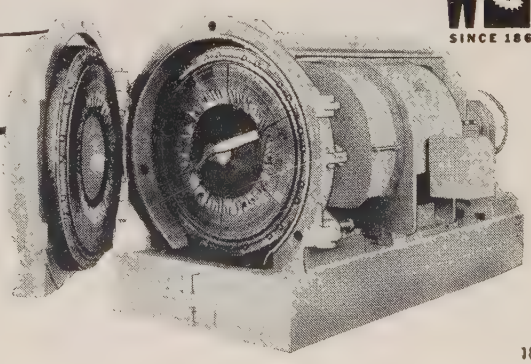

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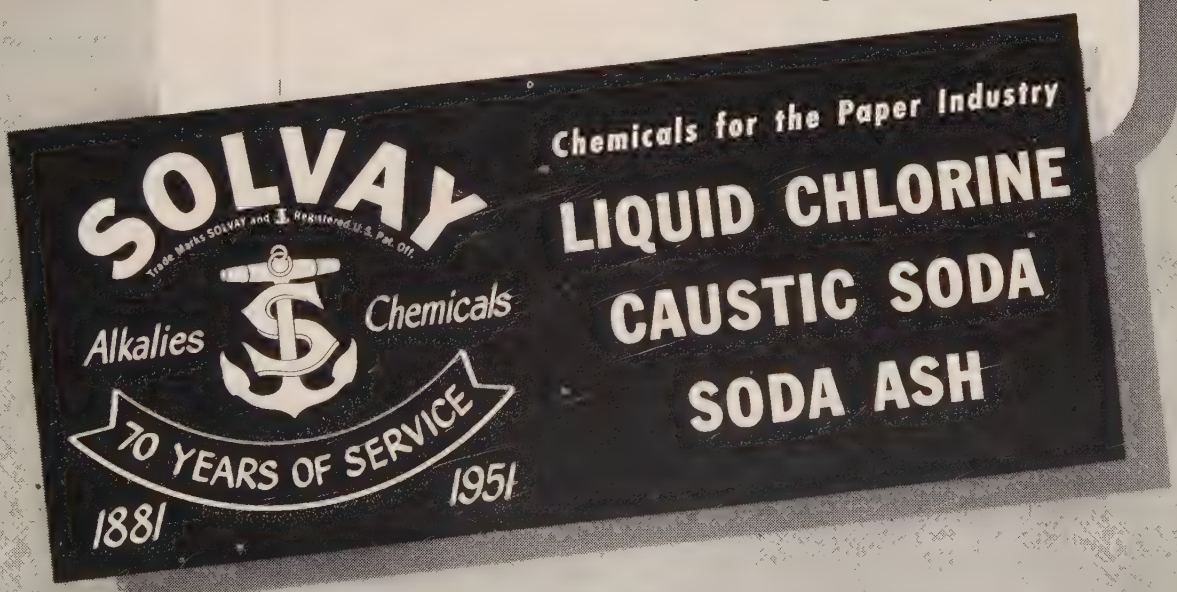

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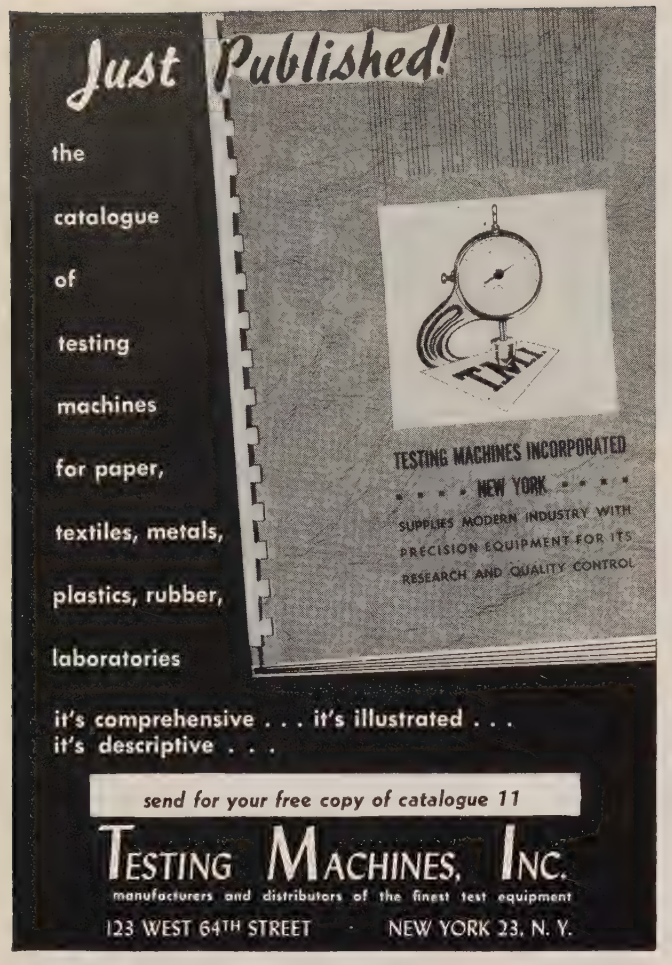

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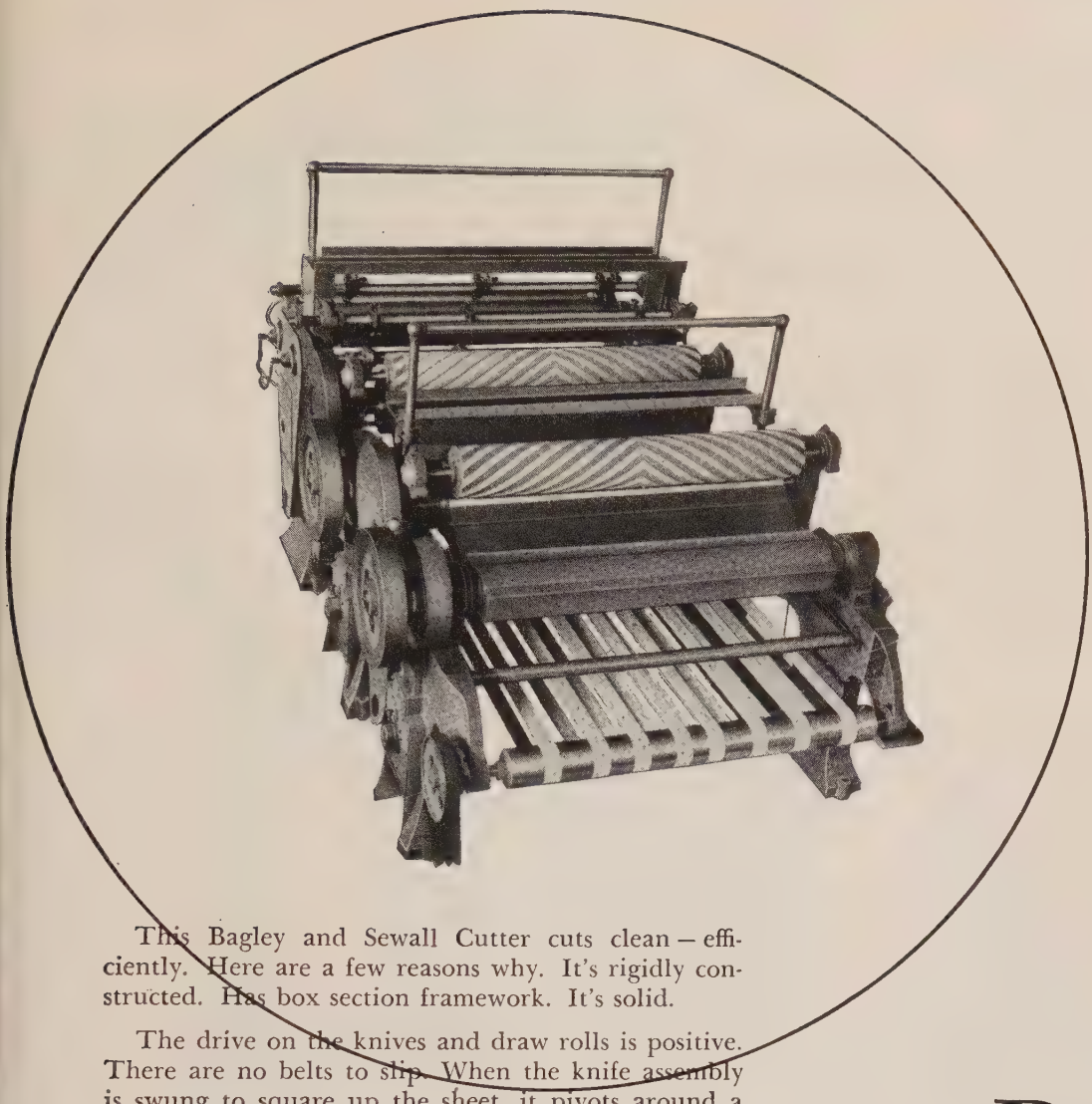

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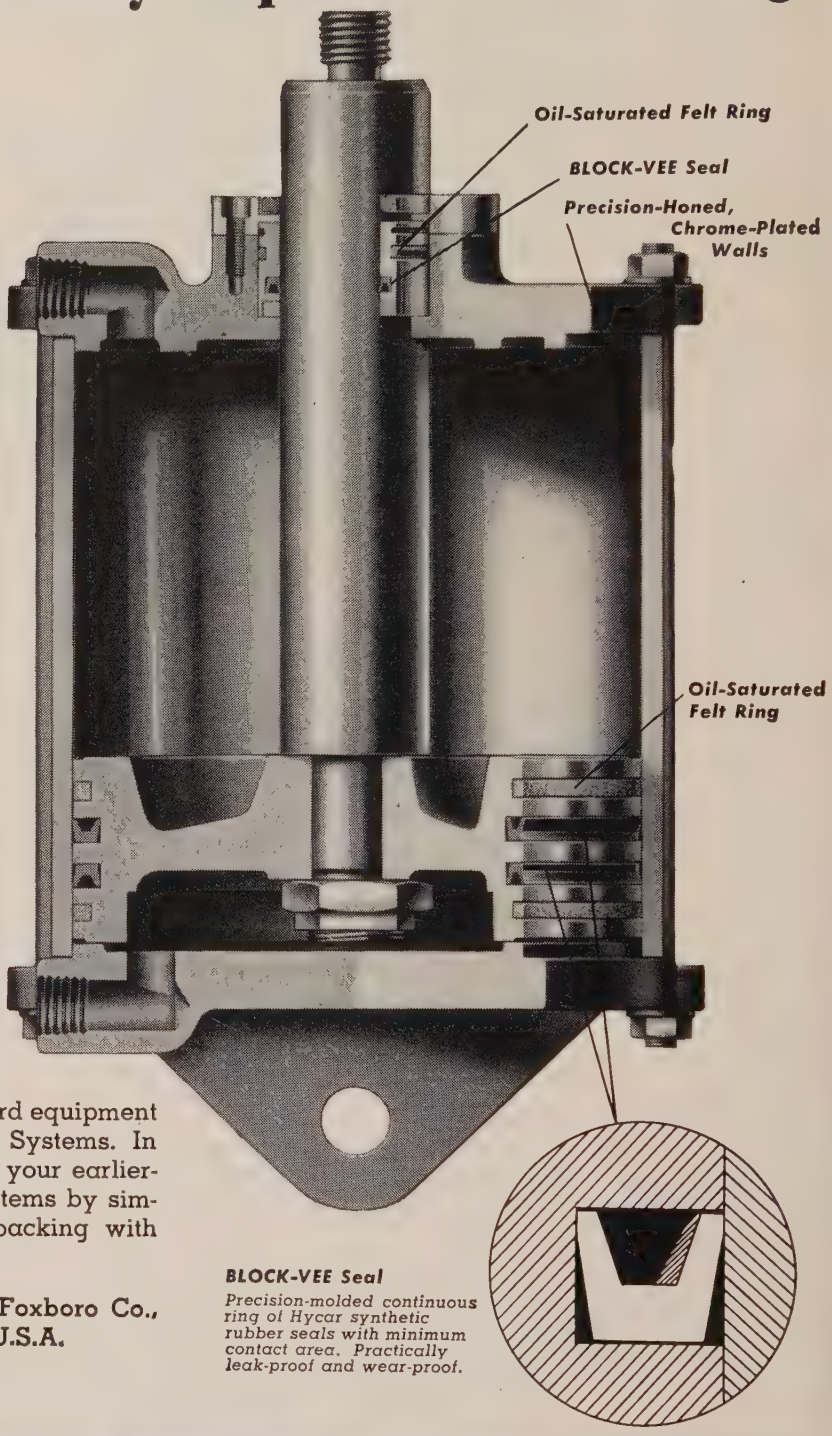

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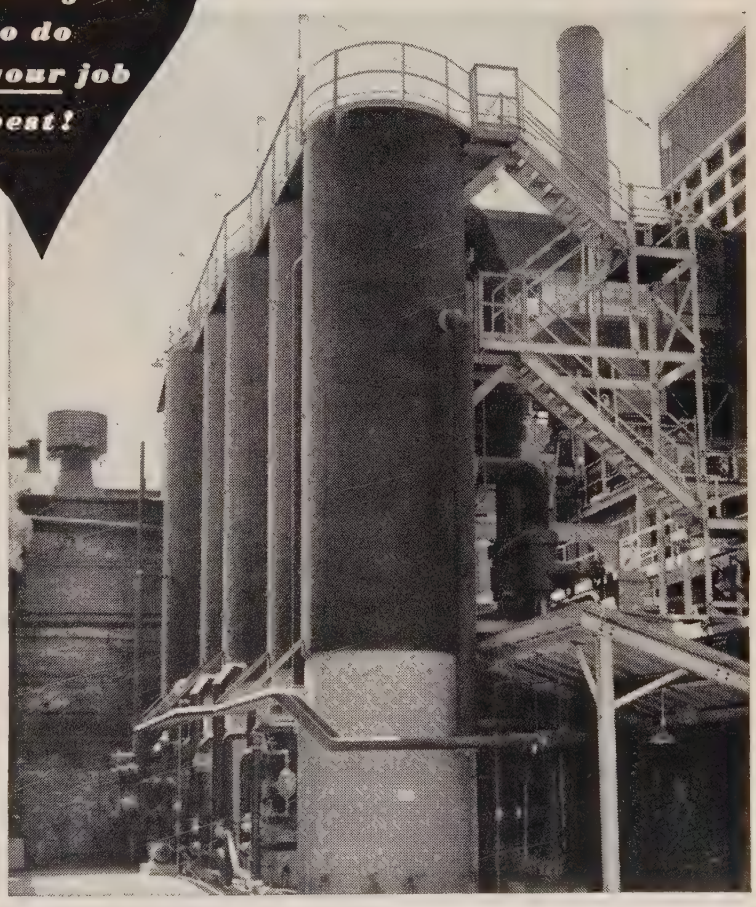

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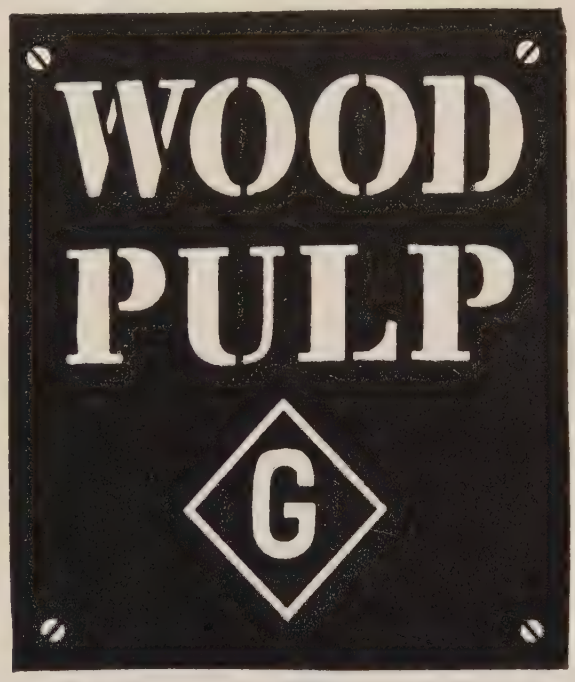

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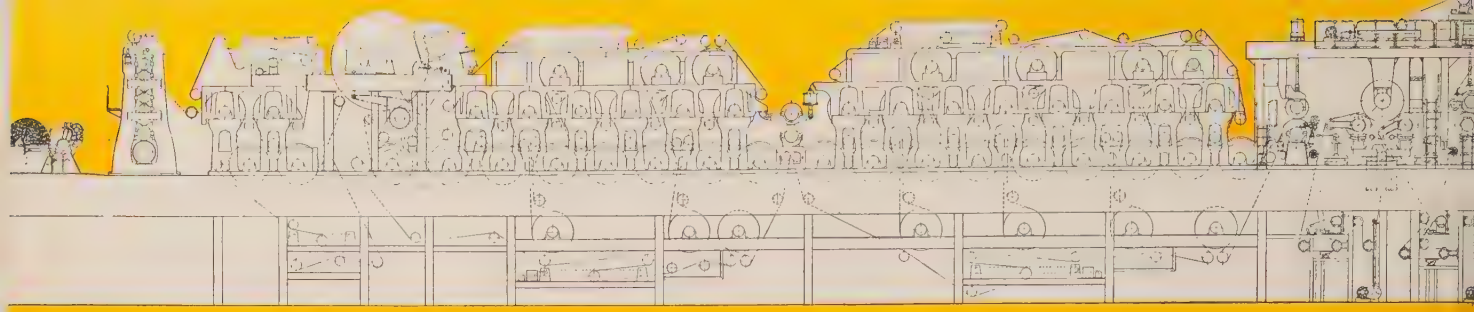

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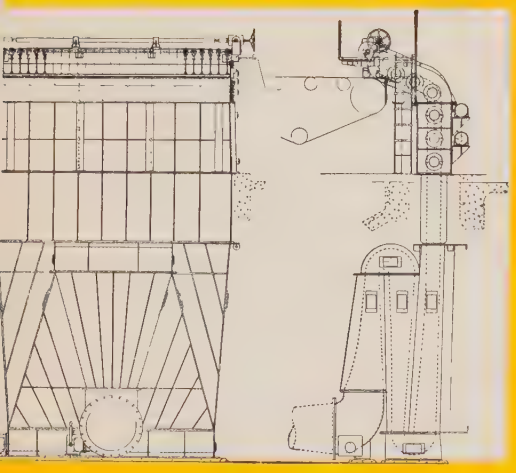

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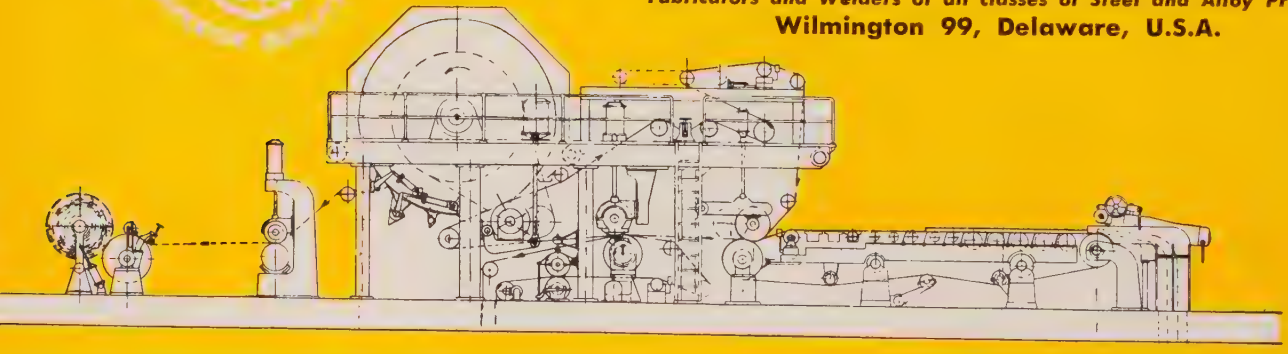

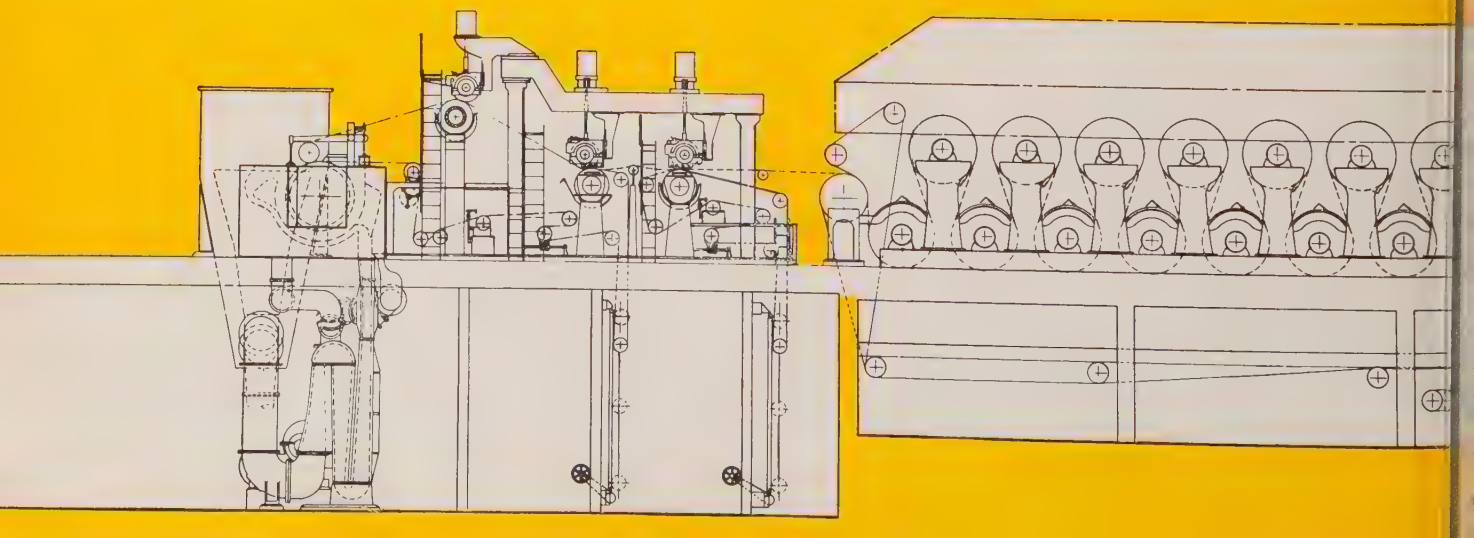

Resin Bonding of Hardwood Fibers in Offset Papers

BOURDON W. SCRIBNER, MERLE B. SHAW, MARTIN J. O'LEARY, and JOSHUA K. MISSIMER

A further investigation was made of the application of resin bonding to the development of strength in offset papers made principally of short hardwood fibers which develop little strength by the conventional beating. Melamine-formaldehyde resin was used. The papers were made from hardwood pulps produced at the U. S. Forest Products Laboratory in experimental study of the pulping of aspen, black gum, paper birch, and beech. The pulps were prepared by the mechanical, sulphate, soda, sulphite, and neutral sulphite processes. By the use of the melamine resin, papers having good strength and resistance to pick, combined with low expansion and curl, were produced with very little beating. The pulps which gave the best results comprised aspen sulphate, aspen soda, aspen sulphite, birch sulphite and black gum sulphate. Resin-bonded papers containing 75% of these pulps compared favorably with papers made in the conventional way with the usual 50% of commercial hardwood fibers. An appreciable increase in the proportion of hardwood fibers used in offset papers would greatly extend pulpwood resources.

Effective utilization of large quantities of hardwoods is an outstanding pulpwood problem. The pulp and paper industry has had an amazing growth during this century but the supply of the more generally used pulp woods is steadily decreasing. Wood is the most important source of papermaking material. Pulp produced from coniferous or needle-leaved trees (softwoods), such as spruce, fir, and pine, is used to a much greater extent than that produced from the hardwood or broad-leaved trees, such as the various "poplars," birch, beech, gum, etc., commonly used for pulping. The use of hardwoods for pulping is good forestry practice, and in regions having a large volume of hardwood species or inferior trees unsuited for lumber or similar products is an economic necessity.

In comparison with spruce and other softwoods, however, the use of hardwoods has been limited by the characteristics of the hardwood fibers. The characteristics that affect the manufacture of paper vary in kind and quantity with different woods. One differentiation is the length of fiber, which is approximately from 1 to 1.5 mm. for hardwoods and from 2.5 to 4.5 mm. for coniferous wood. The fiber of the hardwood trees also has a different structure than that of the conifers. Its soft and absorbent texture renders it useful for bulky papers such as certain classes of printing paper, but it is not as strong as the softwood fiber.

The strength of paper depends on the strength of its fibers and on the adhesive bond between them. Cellulose is a colloid. It gelatinizes ("hydrates") on beating it in water and thus causes gel-like bonds to be formed between the fibers of the finished sheet. Because of the large increase in external surface (fibrillation) produced by beating, the number of contacts and subsequent bonds is greatly increased, thereby increasing the strength of the paper. The hardwoods do not develop good bonding quality to the extent that conifers do.

The development of strength by beating the fibers tends to affect adversely some properties needed for good printing quality. Chief among these are high opacity, good oil absorption, high permeability to air, low expansivity, and low curl. Low expansion and contraction are particularly important in lithographic offset papers for good register of successive color prints, as in printing maps which may be run through the press as many as fifteen times. Hardwood pulps have all the properties needed for good offset printing paper except strength.

An investigation at the Bureau during World War II resulted in the development of offset lithographic paper for war maps having great strength imparted by melamine-formaldehyde resin bonding and excellent printing quality (*1*). A subsequent investigation of the use of melamine-formaldehyde resin in papers made from various mixtures of a commercial softwood pulp and two commercial hardwood pulps showed that the proportion of the latter could be largely increased without impairment of the strength of the papers, and with improvement of their printing quality, thus permitting increased use of hardwood fibers (*2*).

The investigation reported herein is an extension of such study of hardwood pulp to pulps produced experimentally from different species of woods at the U. S. Forest Products Laboratory, in a study of application of the various commercial pulping processes to hardwoods. The cooperation of the Laboratory in furnishing the pulps for the investigation is gratefully acknowledged to George M. Hunt, Director, and G. H. Chidester, Chief, Division of Pulp and Paper.

This investigation and the previous investigations dealing with offset papers were conducted with the counsel of an advisory committee of technicians of the papermaking and printing industries, under the Chairmanship of R. F. Reed, Research Consultant, Lithographic Technical Foundation.

The investigation was made under the direction of Charles G. Weber, deceased.

EXPERIMENTAL PAPERMAKING EQUIPMENT

The papermaking equipment at the Bureau is semi-commercial in size, and is adapted to the experimental manufacture of papers under conditions that simulate those of typical industrial plants. Detailed descriptions are contained in previous publications (*3*, *4*, *5*). The equipment used in this particular work consisted essentially of a 50-pound beater with copper-lined tub and manganese-bronze bars and plate; a jordan refiner with bars of brozne and steel alloy; a four-plate

Bourdon W. Scribner, Merle B. Shaw, Martin J. O'Leary, and Joshua K. Missimer, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C.

flat screen; a 29-inch fourdrinier papermaking machine with a wire 33 feet in length, two presses, nine 15-inch driers, a calender stack of seven rolls, and a reel; and a five-roll supercalender.

FIBROUS RAW MATERIALS

Two commercial pulps, bleached sulphite (coniferous) and bleached soda (deciduous), were used in various mixtures with the hardwood pulps prepared by the Forest Products Laboratory.

Bleached sulphite, made by cooking eastern spruce wood in a solution of calcium bisulphite, is a standard quality of pulp widely used in offset papers. It is composed of relatively long, strong fibers that hydrate rather readily with beating.

Soda pulp is a short-fibered filler-type pulp made by cooking hardwood in a solution of caustic soda. The fibers are characteristically soft and bulky, and do not hydrate readily. The pulp had excellent strength for a pulp of this kind.

The hardwood pulps supplied by the Forest Products Laboratory were prepared from the following deciduous woods: aspen, black gum (tupelo), paper birch, and beech. Also included was a coniferous pulp made from Douglas-fir. The pulps were prepared by the mechanical (groundwood), sulphate, soda, sulphite, and neutral sulphite (semichemical) processes. The identification number assigned to each pulp by the Forest Products Laboratory, and the description of it received from the Laboratory, follow:

Quaking Aspen Pulps

(a) Unbleached free* groundwood pulp (item 1): This pulp is characterized by its relatively short fiber length, low strength, and high freeness. It was prepared at a high rate of production and with low energy consumption. The energy requirement was about 40% that of the slower pulp described below (c).

(b) Peroxide-bleached free groundwood pulp (item 2): This pulp was bleached at a high density by a conventional single-stage sodium peroxide process to give a bright, free, low-strength, short-fibered pulp.

(c) Unbleached book-grade groundwood pulp, slow (item 14): This pulp is characterized by its low freeness, short fiber length, and fair strength. The production rate was low and the energy requirement high.

(d) Bleached sulphate pulp (item 7): A fully bleached sulphate pulp, conventionally cooked, and bleached by a three stage, chlorination—alkali extraction—hypochlorite, bleaching process. This pulp is typical of short-fibered pulps having good strength and softness.

(e) Bleached soda pulp (item 15): This pulp was produced by the conventional soda process and bleached by a three-stage, chlorination—caustic extraction—hypochlorite, bleaching process. This short-fibered pulp was slow hydrating and relatively weak, as is typical for this kind of pulp, but was soft and bulky.

(f) Bleached sulphite pulp (item 16): This was a commercial pulp prepared by the calcium-bisulphite process and bleached by the conventional single-stage hypochlorite process. It is a weak, short-fibered pulp, typical of aspen sulphite.

(g) Bleached neutral sulphite (semichemical) pulp

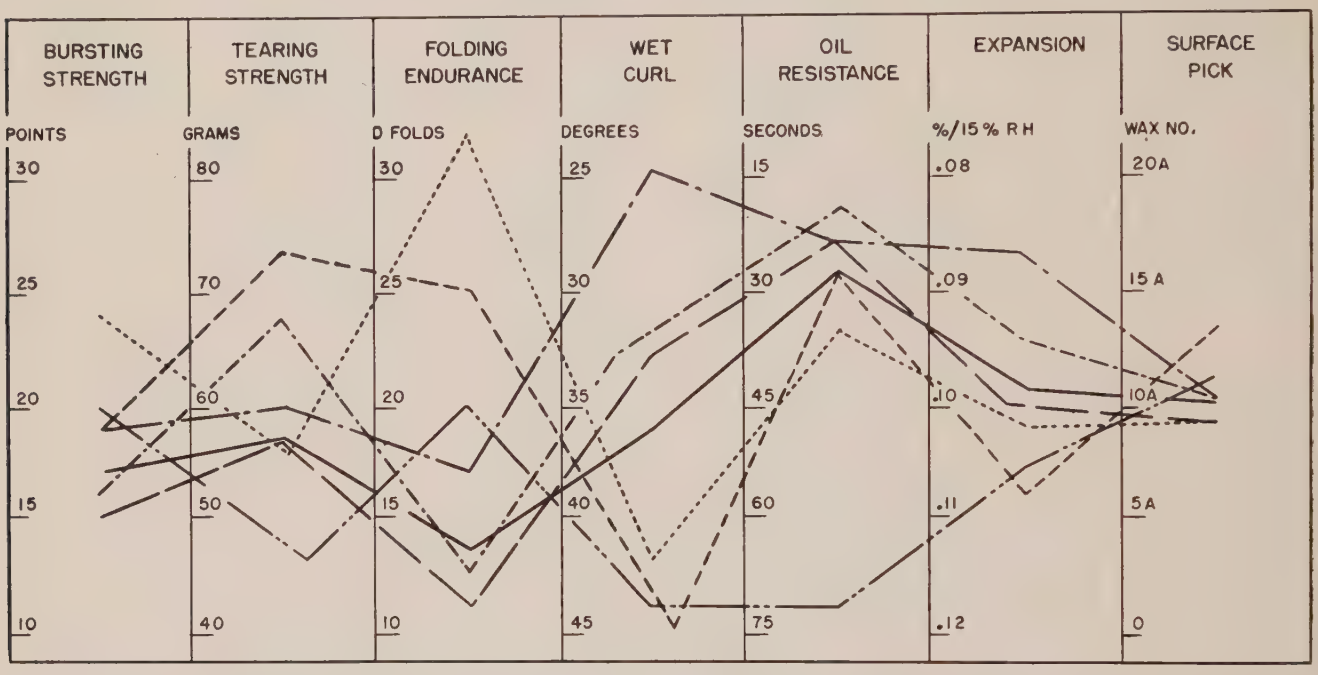

Fig. 1. For papers containing 1% of melamine resin, the physical properties of experimental papers composed of 75% hardwood fibers and 25% sulphite softwood fibers are as good as, and in some instances better than, papers composed of 50% commercial soda hardwood fibers and 50% commercial sulphite softwood fibers

— 1560, 50% strong soda pulp, 50% eastern sulphite (commercial); — — 1538, 75% bleached aspen sulfate, 25% eastern sulphite (commercial); — · — 1558, 75% bleached aspen soda, 25% eastern sulphite (commercial); — · · — 1542, 75% bleached aspen sulphite, 25% eastern sulphite (commercial); - - - - 1516, 75% bleached black gum sulphate, 25% eastern sulphite (commercial); — · · · — 1534 75% bleached paper birch sulphite, 25% eastern sulphite (commercial); - - - - - 1502, 40% strong soda pulp, 60% bleached sulphate (67% aspen, 33% spruce).
(All the above with 1% melamine resin.)

* "Free" is a term applied to fibers from which water drains rapidly because of the low hydration of the fibers. The converse term is "slow."

(item 5): The cooking process consisted of partially digesting the aspen chips with a solution of sodium sulphite and sodium bicarbonate and then defibering the softened chips in an attrition mill. The pulp was bleached by a conventional multistage process including chlorination, alkali extraction, and hypochlorite treatment. A high yield of fully bleached pulp was obtained. It is characterized by fairly high strength, rapid hydration, and considerable hardness.

(h) Mixed aspen and spruce bleached sulphate pulps (item 3): Sulphate pulp was made be a conventional pulping procedure from a mixture of quaking aspen (67%) and spruce (33%) and bleached by a multistage treatment consisting of chlorination, alkali extraction, two-stage hypochlorite bleaching, and a sulphur dioxide wash. This pulp had a much lower bursting strength and a somewhat lower tearing strength than would be expected if less drastic bleaching conditions had been used. The mixture of long and short fibers in this pulp had a higher tearing resistance than the pulp made from the hardwood alone.

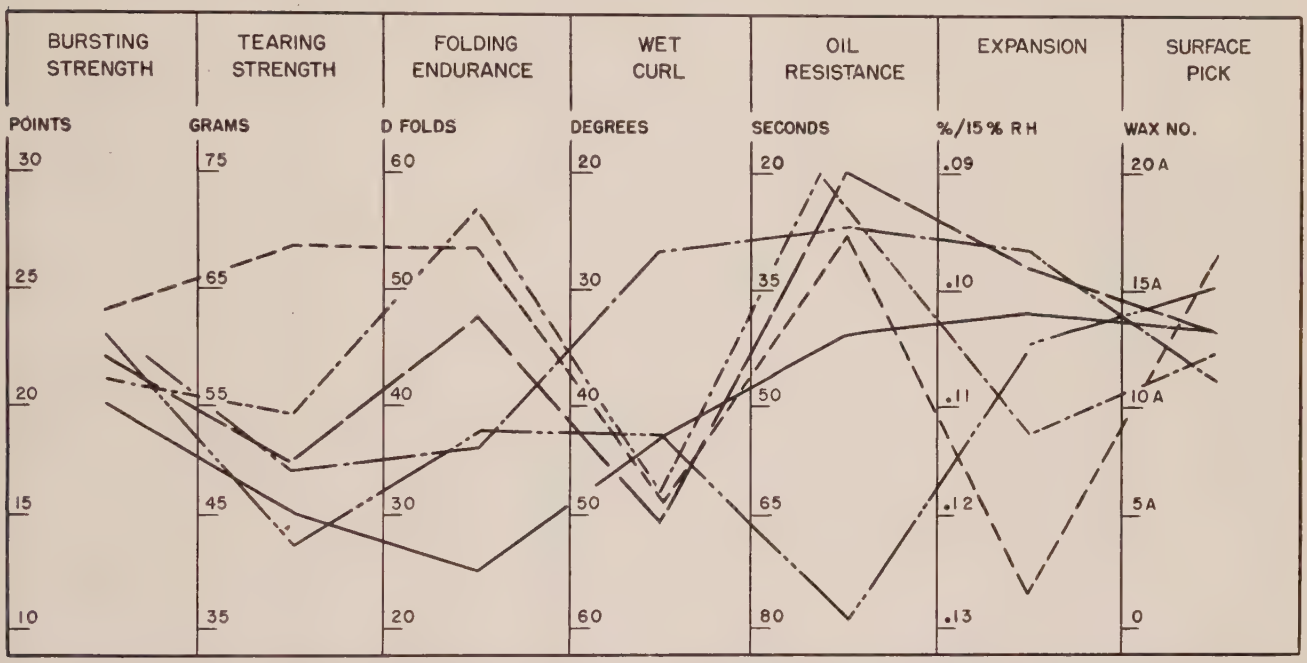

Fig. 2. For papers containing 3% of melamine resin, the physical properties of experimental papers composed of 75% hardwood fibers and 25% sulphite softwood fibers are better in most instances than the papers composed of 50% commercial soda hardwood fibers and 50% commercial sulphite softwood fibers

— 1561, 50% strong soda pulp, 50% eastern sulphite (commercial); — — 1539, 75% bleached aspen sulphate, 25% eastern sulphite (commercial); — · — 1559, 75% bleached aspen soda, 25% eastern sulphite (commercial); — · · — 1543, 75% bleached aspen sulphite, 25% eastern sulphite (commercial); – – – – 1517, 75% black gum sulphate, 25% eastern sulphite (commercial); – · – · – 1535, 75% bleached paper birch sulphite, 25% eastern sulphite (commercial).
(All the above with 3% melamine resin.)

Black Gum (Tupelo) Pulp

Bleached sulphate pulp (item 6): A bleachable sulphate pulp was made by a conventional sulphate pulping procedure and the pulp bleached by a multistage process involving chlorination, alkali extraction, and two stage hypochlorite bleaching. A bright, fairly strong, and fairly soft short-fibered pulp was obtained. The bursting strength of the pulp was perhaps lower than would normally result from less drastic treatment.

Paper Birch Pulps

(a) Peroxide-bleached groundwood pulp (item 8): This pulp is very short fibered and has a correspondingly low strength. It was bleached to high brightness by a high-density single-stage peroxide process.

(b) Bleached sulphite pulp (item 10): The pulp was produced by the conventional sulphite process using calcium-base liquor. The pulp was bleached by a conventional two-stage chlorine-hypochlorite process. It is a fairly strong short-fibered pulp.

(c) Bleached neutral sulphite (semichemical) pulp (item 9): The wood was partially pulped with a sodium sulphite and sodium bicarbonate liquor and the softened chips were then defibered in an attrition mill. The semichemical pulp was bleached by a multistage, chlorination—alkali extraction—hypochlorite, bleaching process. The fully bleached pulp was characterized by high yield, high strength, rapid hydration, and considerable hardness.

Beech Pulp

Bleached sulphate pulp (item 12): The wood was pulped by a conventional sulphate pulping procedure. The pulp was bleached by a multistage process comprising chlorination, alkali extraction, and two-stage hypochlorite bleaching. This pulp was somewhat underbleached to give a fair brightness. The pulp is short fibered and of fair strength.

Douglas-Fir Pulp

Bleached neutral sulphite (semichemical) pulp (item 13): A fully bleached pulp was made from Douglas-fir (coniferous) by partial cooking with a sodium sulphite and sodium bicarbonate liquor followed by defibering the softened chips in an attrition mill. A fairly high yield of unbleached pulp was obtained.

Table I. Comparative Data on Offset Papers Made from Hardwood Fibers Bonded with

Run no.	Pulp	Forest products item no.	Melamine-formaldehyde resin added, %	Weight[a] (25 × 40—500), lb.	Thickness, in.	Bursting strength, pt.	Folding endurance, double folds MIT (Tension 1 kg.)		Tensile strength, kg.		Tearing resistance, g.	
							Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
1492	75% unbleached aspen groundwood	1	..	56.3	0.0051	11	3	2	3.6	2.3	41	44
1494	25% bleached "Eastern" sulfite	..	1	53.9	0.0052	14	4	3	4.0	2.8	39	42
1493	.....	..	3	55.0	0.0053	18	8	7	5.5	3.4	35	39
1498	75% unbleached aspen groundwood	1	..	55.9	0.0042	11	3	2	3.6	2.6	31	34
	25% bleached aspen neutral sulphite (semichemical)	5	..	..	....	..	..	..	..	..	..	..
1544	75% peroxide-bleached aspen groundwood	2	..	54.4	0.0042	13	7	4	9.1	6.0	28	41
1545	25% bleached "Eastern" sulphite	..	1	53.1	0.0039	13	10	7	9.7	7.2	34	34
1546	.....	..	3	55.4	0.0042	17	16	11	11.8	8.2	35	37
1523	75% unbleached aspen groundwood (slow)	14	..	52.8	0.0038	13	7	8	4.0	3.1	32	32
1524	25% bleached "Eastern" sulphite	..	1	55.2	0.0039	15	9	13	4.5	3.6	32	32
1525	.....	..	3	55.0	0.0038	18	24	26	5.7	4.1	29	30
1526	100% unbleached aspen groundwood (slow)	14	3	54.7	0.0037	14	1	1	5.5	3.7	21	22
1537	.....	..	..	55.4	0.0040	8	2	2	2.7	2.0	58	56
1538	75% bleached aspen sulphate	7	1	55.2	0.0039	15	11	11	4.8	3.6	57	57
1539	25% bleached "Eastern" sulphite	..	3	54.6	0.0037	22	52	43	5.8	4.2	50	50
1572[b]	.....	..	..	56.8	0.0039	15	7	6	4.8	3.3	57	58
1557	.....	..	..	55.5	0.0037	9	3	3	3.3	2.1	51	61
1558	75% bleached aspen soda	15	1	56.5	0.0037	19	20	14	5.4	3.7	60	60
1559	25% bleached "Eastern" sulphite	..	3	55.0	0.0034	22	42	30	6.3	4.4	51	48
1573[b]	.....	..	..	54.7	0.0038	14	8	5	4.9	3.2	47	54
1541	75% bleached aspen sulphite	16	..	56.6	0.0036	14	9	6	11.2	6.9	50	51
1542	25% bleached "Eastern" sulphite	..	1	56.4	0.0036	20	27	13	14.6	9.1	44	48
1543	.....	..	3	56.3	0.0034	23	44	31	16.9	10.9	43	42
1495	75% bleached aspen neutral sulphite (semichemical)	5	..	56.3	0.0038	23	84	42	7.5	4.3	53	56
	25% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1496	50% bleached aspen neutral sulphite (semichemical)	5	..	56.0	0.0037	20	26	16	6.3	4.0	48	53
	50% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1497	25% bleached aspen neutral sulphite (semichemical)	5	..	56.1	0.0039	14	8	6	4.6	3.2	45	52
	75% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1499	67% bleached aspen, 33% bleached spruce sulphate	3	..	56.4	0.0039	20	32	13	6.5	3.4	73	78
1500	.....	..	1	56.3	0.0037	29	97	54	7.6	4.6	60	64
1501	40% bleached aspen, 20% bleached spruce sulphate	3	..	55.0	0.0040	16	11	7	5.1	3.1	58	63
1502	40% bleached strong soda	..	1	55.5	0.0040	24	46	17	6.9	4.4	53	59
1503	75% bleached black gum (tupelo) sulphate	6	..	54.4	0.0042	11	4	3	3.0	2.1	66	75
1516	25% bleached "Eastern" sulphite	..	1	55.2	0.0037	19	27	23	5.0	3.5	71	75
1517	.....	..	3	53.1	0.0038	24	57	49	5.6	4.1	71	65
1518	100% bleached black gum (tupelo) sulphate	6	3	54.2	0.0039	24	57	50	5.6	4.1	69	71
1519	75% peroxide-bleached paper birch groundwood	8	..	52.8	0.0039	9	2	2	1.4	1.1	30	32
1520	25% bleached "Eastern" sulphite	..	1	52.6	0.0038	11	3	3	3.9	2.6	27	29
1521	.....	..	3	52.3	0.0037	14	4	4	4.5	2.9	24	28
1533	75% bleached paper birch sulphite	10	..	54.2	0.0036	9	4	2	3.0	1.8	64	70
1534	25% bleached "Eastern" sulphite	..	1	54.6	0.0036	16	16	9	4.3	2.7	67	68
1535	.....	..	3	52.4	0.0034	21	79	35	5.6	3.6	54	55
1508	75% bleached paper-birch neutral sulphite (semichemical)	9	..	53.1	0.0034	38	382	169	9.6	5.6	51	59
	25% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1509	50% bleached paper-birch neutral sulphite (semichemical)	9	..	54.5	0.0035	28	103	41	7.7	4.7	48	54
	50% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1510	25% bleached paper-birch neutral sulphite (semichemical)	9	..	55.7	0.0037	20	19	13	6.1	3.9	48	53
	75% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1568	.....	..	..	53.3	0.0037	9	3	2	2.7	1.8	53	53
1569	75% bleached beech sulphate	12	1	54.9	0.0039	13	4	6	3.4	2.4	52	50
1570	25% bleached "Eastern" sulphite	..	3	52.9	0.0040	17	10	10	4.7	3.6	50	47
1571[b]	.....	..	..	53.1	0.0039	14	6	6	4.4	3.0	46	44
1529	75% bleached Douglas-fir neutral sulphite (semichemical)	13	..	52.9	0.0036	21	163	53	5.5	3.4	112	128
	25% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1530	50% bleached Douglas-fir neutral sulphite (semichemical)	13	..	54.1	0.0035	19	79	28	5.1	3.2	98	112
	50% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1531	25% bleached Douglas-fir neutral sulphite (semichemical)	13	..	54.0	0.0036	15	14	9	4.2	2.8	79	87
	75% bleached strong soda	..	..	..	....	..	..	..	..	..	..	..
1562	75% bleached strong soda	..	..	53.2	0.0034	9	4	4	3.3	2.5	47	49
1563	25% bleached "Eastern" sulphite	..	1	54.0	0.0033	16	10	8	4.8	3.5	46	47
1564	.....	..	3	54.3	0.0033	19	18	16	5.4	4.0	46	44
1540	50% bleached strong soda	..	..	54.8	0.0040	12	6	4	3.7	2.6	61	63
1560	50% bleached "Eastern" sulphite	..	1	54.4	0.0036	17	15	12	4.7	3.3	57	58
1561	.....	..	3	53.6	0.0031	20	29	21	5.9	3.8	46	44

[a] All physical tests made under conditions of 50% relative humidity and 73°F. by the standard methods of the Technical Association of the Pulp and Paper Industry, except Carson air permeability.
[b] Stock was given more drastic beating in an attempt to obtain greater strength without the use of a bonding resin.

It was bleached by a conventional, chlorination—alkali extraction—hypochlorite, bleaching process. The pulp is characterized by its high strength, especially tearing resistance, and long fibers.

MANUFACTURING PROCEDURE

A series of papers was made from the pulps with and without the resin bonding. The manufacturing factors were kept as nearly constant as possible. The

Expansivity (15% change in relative humidity), %								
Machine direction	Cross direction	Opacity (contrast ratio), %	Smoothness (Bekk), Sec.	Pick (Dennison waxes), wax no.	Oil penetration, sec.	Air permeability, cm.³/sec./m.²/g./cm.²	Sizing value (dry indicator), sec.	Curl, degrees
0.053	0.135	97.0	23	2A	60	402	77	25
0.065	0.147	95.4	21	5A	71	337	79	31
0.061	0.166	94.9	18	9A	76	239	86	32
0.070	0.164	94.6	56	4A	77	183	81	32
...	...	..	..	..	..	..	..	..
0.061	0.153	91.0	57	6A	112	167	90	36
0.073	0.146	90.5	53	10A	134	145	102	28
0.070	0.187	91.0	46	10A	131	101	113	29
0.075	0.157	97.0	109	9A	271	31	81	36
0.080	0.174	97.0	97	11A	332	26	82	45
0.083	0.199	97.0	85	14A	503	14	88	51
0.091	0.202	98.0	97	13A	649	9	86	50
0.056	0.116	86.0	47	2A	25	1163	68	27
0.060	0.140	85.0	51	9A	24	898	68	33
0.062	0.135	84.0	56	13A	26	724	62	51
0.061	0.152	86.0	66	6A	31	419	63	39
0.058	0.116	86.0	84	2A	22	900	41	27
0.048	0.126	87.0	75	10A	24	719	57	25
0.051	0.143	85.0	89	11A	27	584	57	27
0.050	0.148	86.0	66	5A	30	422	63	37
0.055	0.151	86.0	73	5A	67	198	102	40
0.057	0.159	85.0	69	11A	72	149	104	44
0.056	0.154	84.0	68	15A	79	130	126	43
0.086	0.282	79.1	27	12A	81	114	69	120
...	...	..	..	..	..	..	..	..
0.078	0.219	83.8	55	10A	56	189	73	70
...	...	..	..	..	..	..	..	..
0.071	0.184	88.0	58	5A	31	364	67	50
...	...	..	..	..	..	..	..	..
0.053	0.173	85.2	53	6A	37	405	73	41
0.066	0.164	85.9	48	10A	40	318	78	44
0.057	0.135	88.2	61	5A	32	434	77	37
0.058	0.146	87.0	63	9A	36	373	77	42
0.071	0.160	83.0	36	3A	15	1675	50	35
0.070	0.146	84.0	92	13A	28	834	58	45
0.073	0.181	83.0	50	16A	26	975	60	49
0.079	0.175	82.0	40	16A	20	1537	55	46
0.061	0.141	94.0	88	2A	79	150	54	31
0.064	0.162	93.0	113	6A	87	131	25	31
0.063	0.181	93.0	113	10A	123	77	33	37
0.052	0.137	84.0	68	2A	25	1638	66	33
0.049	0.140	83.0	54	10A	20	1359	73	33
0.056	0.169	80.0	53	12A	20	1178	72	48
0.098	0.303	76.0	47	18A	224	43	57	144
...	...	..	..	..	..	..	..	..
0.091	0.252	83.0	66	13A	99	112	59	92
...	...	..	..	..	..	..	..	..
0.082	0.195	88.0	115	10A	59	235	56	58
...	...	..	..	..	..	..	..	..
0.059	0.133	88.0	66	2A	16	1397	51	38
0.050	0.133	89.0	47	6A	15	1227	60	35
0.055	0.150	88.0	45	11A	17	1102	57	36
0.060	0.174	86.0	52	10A	27	565	55	42
0.061	0.165	79.0	66	11A	62	302	50	48
...	...	..	..	..	..	..	..	..
0.061	0.164	85.0	62	10A	61	326	56	47
...	...	..	..	..	..	..	..	..
0.048	0.133	88.0	70	7A	52	425	61	36
...	...	..	..	..	..	..	..	..
0.049	0.123	91.0	148	3A	36	416	53	32
0.056	0.132	90.0	147	7A	36	359	69	33
0.054	0.136	89.0	151	11A	38	327	67	36
0.049	0.126	88.0	64	3A	34	556	93	31
0.056	0.142	87.0	79	10A	28	309	45	36
0.058	0.146	87.0	166	13A	41	295	69	43

pulps were beaten for $1^1/_2$ hours, which was considered the minimum time for satisfactory results.

Fifty pounds of pulp and 1% (based on weight of fiber) of rosin size were used for each machine run.

The beaten stock was dropped directly to a chest from which it was pumped in a continuous stream through the stuff box and the jordan refiner to the paper machine. The stuff box was of the regulating type with constant head over an adjustable orifice. The jordan was used as a mixer only, with the same setting for all papers.

The melamine-formaldehyde resin was added in the form of a colloidal solution made by dissolving the

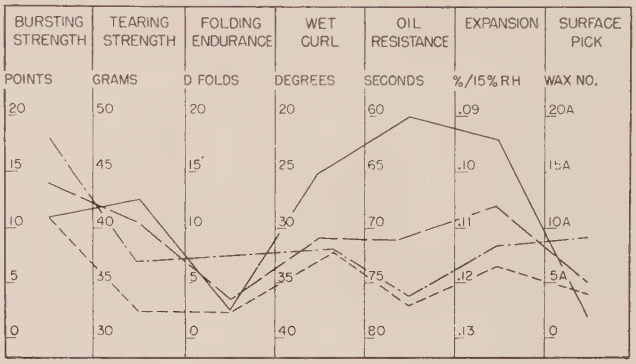

Fig. 3. Effect of melamine resin in papers containing unbleached aspen groundwood pulp (FPL item 1)

— 1492, blank, 75% unbleached aspen groundwood, 25% bleached eastern sulphite; — — 1494, 1% M, 75% unbleached aspen groundwood, 25% bleached eastern sulphite; — · — 1493, 3% M, 75% unbleached aspen groundwood, 25% bleached eastern sulphite; – – – – 1498, blank, 75% unbleached aspen groundwood, 25% aspen neutral sulphite.

powdered resin in warm water acidified with hydrochloric acid. The solution was added continuously at uniform rate to the papermaking stock just before it entered the headbox of the paper machine. The temperature of the stock at the headbox was maintained at 90 ± 2°F.

Melamine is a triamino derivative of symmetrical triazine consisting of a six-membered ring of alternate carbon and nitrogen atoms. It was discovered by Von Liebig in 1834 who, thinking it was the amine of melam, called it melamine. The particles of the colloidal resin have a positive charge and, since cellulose is negatively charged, they are therefore quickly adsorbed on the cellulose fiber. The heat of the paper machine drying cylinders completes the polymerization of the resin particles, forming a water-insoluble bond between the fibers.

The finish imparted by the small paper machine calender was relatively low, therefore the papers were given light supercalendering to obtain a smoothness comparable to commercial "machine finish."

SAMPLING AND TESTING

The method of sampling paper from a machine run in the paper mill was as follows: the paper wound on the reel of the paper machine was slit across the web, thereby being converted into a stack of sheets. The stack was then cut so as to give an entire cross section of the sheets for sampling. The resultant stack was divided into seven parts. From the first part, 13 sheets were laid out as the first sheets of 13 packs to be built up. From the second part, 13 sheets were likewise distributed as the second sheets of the packs. From each of the seven parts, respectively, a sheet

was added to each pack. The procedure was then repeated until all the paper had been distributed into the 13 packs. The odd-numbered (1, 3, 5, 7, 9, 11, 13) packs were then assembled, one above the other, to make one bundle of paper, and similarly the even-numbered packs to make another. From these bundles sheets were taken for the test samples.

All tests of the papers were made according to the Standard Methods of the Technical Association of the Pulp and Paper Industry except the air permeability test by the Carson method. This was determined with a Carson Precision Permeability Tester (*6*) which measures the rate of air flow through the paper per unit of area with a pressure difference of 1 gram per sq. cm.

DISCUSSION OF PAPERS AND DATA

The complete test data for the papers are given in Table I. Table II shows the consistent improvement in strength obtained with melamine resin irrespective of the kind of experimental pulping processes used.

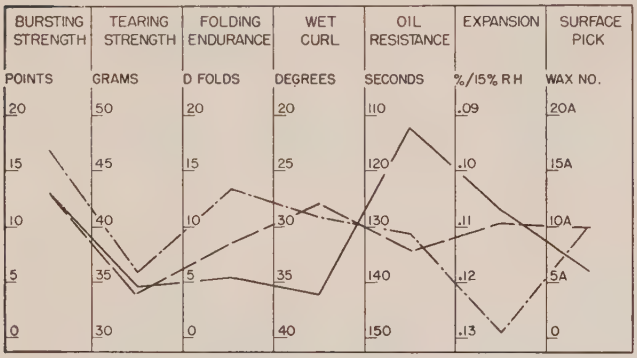

Fig. 4. Effect of melamine resin in papers containing eroxide -bleached aspen groundwood pulp (FPL item 2)

— 1544, blank, 75% peroxide-bleached aspen groundwood, 25% eastern sulphite; — — 1545, 1% M, 75% peroxide-bleached aspen groundwood, 25% eastern sulphite; — · — 1546, 3% M, 75% peroxide-bleached aspen groundwood, 25% eastern sulphite.

Table III shows that for a given pulping process, the improvement in strength by use of melamine resin was uniformly good for different species of wood. The figures show graphically the beneficial effects obtained with the use of the resin with various pulps. The word "blank" in the figures means that no melamine resin was added; an "M" is an abbreviation of melamine resin. Following is a discussion of the effects of melamine resin on the properties of the papers as shown by the data.

Unbleached aspen groundwood, free (item 1): The fiber furnish for the three runs, 1492–1494, was 75% of aspen groundwood. The tests on the papers show that the bursting strength, folding endurance, and tensile strength were all improved by the addition of melamine, the improvement being more pronounced with the greater amount of resin. The bonding resin improved also the resistance of the surface to picking, as measured by the wax test, without excessive increase in expansion of the papers or tendency to curl (Fig. 3).

Melamine resin was not used in run 1498, and an equal amount of bleached aspen neutral sulphite pulp (item 5) was substituted for the sulphite (coniferous) pulp. The aspen pulp was characterized by fairly high strength, rapid hydration, and considerable hardness. The paper showed only fair bursting strength and low folding endurance, tensile strength, tearing strength, and resistance to pick, although the expansivity of the sheet was nearly as much as when 3% of bonding resin was used (run 1493) and the air permeability less. The aspen neutral sulphite pulp was not a good substitute for the resin bonding in developing desirable properties in the finished paper (Fig. 3).

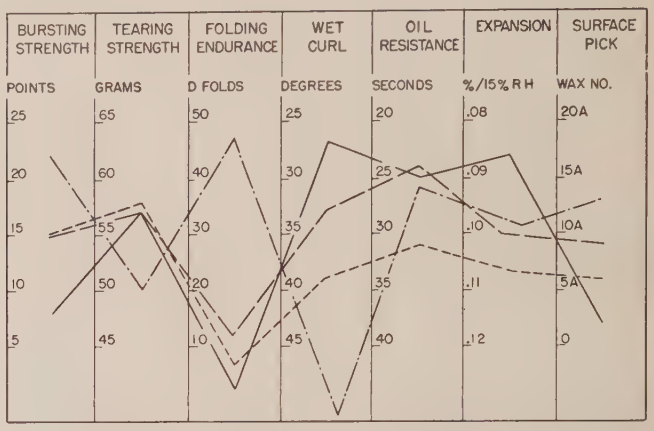

Fig. 5. Effect of melamine resin in papers containing aspen sulphate pulp (FPL item 7)

— 1537, blank, 75% bleached aspen sulphate, 25% eastern sulphite; — — 1538, 1% M, 75% bleached aspen sulphate, 25% eastern sulphite; — · — 1539, 3% M, 75% bleached aspen sulphate, 25% eastern sulphite; – – – – 1572, blank, 75% bleached aspen sulphate, 25% eastern sulphite, long beating time.

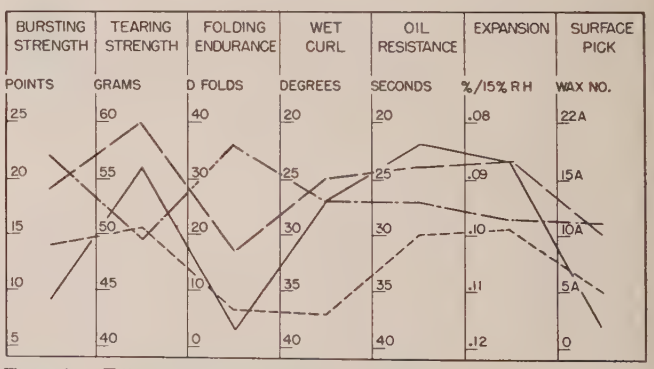

Fig. 6. Effect of melamine resin in papers containing aspen soda pulp (FPL item 15)

— 1557, blank, 75% bleached aspen soda, 25% bleached eastern sulphite; — — 1558, 1% M, 75% bleached aspen soda, 25% bleached eastern sulphite; — · — 1559, 3% M, 75% bleached aspen soda, 25% bleached eastern sulphite; – – – – 1573, blank, longer beating time.

Peroxide-bleached aspen groundwood, slow (item 2): The papers of runs 1544–1546 showed improvement in strength properties as a result of bleaching the pulp but the expansivity was somewhat high when the percentage of bonding resin was increased. Except for improvement in color, whether the effect on other qualities would warrant the extra cost of the bleaching operation is doubtful (Fig. 4).

Unbleached aspen book-grade groundwood pulp, slow (item 14): The strength properties of papers made of this pulp (runs 1523–1526) were better in general than for the papers made from the free unbleached aspen groundwood (item 1), but the expansivity was too high and the air permeability of the sheet very low. The folding endurance for paper (run 1526) made from 100% book-grade groundwood pulp and 3% of bonding resin was almost negligible.

1495–1497) made from this pulp mixed with varying percentages—25, 50, and 75, respectively—of soda pulp (hardwood), with no bonding resin added, were unsatisfactory because of very high expansivity and curl.

Mixed aspen and spruce sulphate pulp (item 3): The papers (runs 1499 and 1500) from 100% sulphate pulp (67% of aspen and 33% of spruce), without and with 1% of bonding resin, had satisfactory strength

Table II. Effect of Melamine Resin on Tensile Breaking Strength of Papers[a] Containing Aspen Pulp Produced by Various Pulping Processes

Amount of melamine, %	Groundwood process kg./15 mm.		Sulphate process kg./15 mm.		Sulphite process kg./15 mm.		Soda process kg./15 mm.	
	Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
..	9.1	6.0	2.7	2.0	11.2	6.9	3.3	2.1
1	9.7	7.2	4.8	3.6	14.6	9.1	5.4	3.7
3	11.8	8.2	5.8	4.2	16.9	10.9	6.3	4.4

[a] 75% aspen (hardwood) pulp, 25% sulphite softwood pulp.

Aspen sulphate pulp (item 7): Papers (runs 1537–1539) with good strength and resistance to surface pick, combined with low expansion, were made from a mixture of this pulp with only 25% of sulphite pulp (coniferous) and having 1 and 3%, respectively, of melamine-formaldehyde resin added for bonding (Fig. 5).

Run 1572 was made to try to develop strength in the paper as a result of beating instead of with melamine resin. The beating did not develop sufficient strength, however, whereas bonding with 3% of melamine-formaldehyde resin produced good strength properties without appreciable beating. The more drastic beating increased the expansivity above that produced by the bonding resin (Fig. 5).

Aspen soda pulp (item 15): Generally satisfactory papers (runs 1557–1559) were obtained with this pulp when either 1 or 3% of bonding resin was used. Drastic beating (run 1573) did not develop the necessary strength in the paper to the extent that 3% of melamine-formaldehyde resin did, and it increased expansivity and greatly reduced air permeability (Fig. 6).

Table III. Effect of Melamine Resin on Tensile Breaking Strength of Papers[a] Containing Hardwood Pulps Produced from Various Species of Wood by the Sulphate Pulping Process

Amount of melamine, %	Aspen, kg./15 mm.		Black gum, kg./15 mm.		Beech, kg./15 mm.	
	Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction
..	2.7	2.0	3.0	2.1	2.7	1.8
1	4.8	3.6	5.0	3.5	3.4	2.4
3	5.8	4.2	5.6	4.1	4.7	3.6

[a] 75% hardwood pulp, 25% sulphite softwood pulp.

Aspen sulphite pulp (item 16): This is another pulp from which papers (runs 1541–1543) with good strength and resistance to surface pick, combined with low expansivity, were produced when bonding resin was used (Fig. 7).

Aspen neutral sulphite pulp (item 5): Papers (runs

properties but with expansivity nearing the border line (Fig. 8).

In order to get a softer sheet with the bleached sulphate, and less expansivity, it was decided to make two more runs (1501–1502) duplicating runs 1499 and 1500 except in the pulp furnish which included a strong hardwood soda pulp. The pulp furnish for the

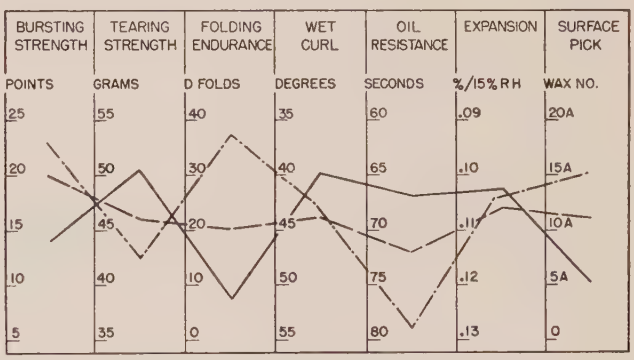

Fig. 7. Effect of melamine resin in papers containing aspen sulphite pulp (FPL item 16)

— 1541, blank, 75% bleached aspen sulphite, 25% bleached eastern sulphite; — — 1542, 1% M, 75% bleached aspen sulphite, 25% bleached eastern sulphite; — · — 1543, 3% M, 75% bleached aspen sulphite, 25% bleached eastern sulphite.

runs (1501–1502) was 40% of sulphate, aspen; 20% of sulphate, spruce; and 40% of soda, hardwood. The strength properties of the papers were fairly good and the expansivity satisfactory, but the resistance to surface picking was somewhat less. However, it is believed that aspen sulphate pulp prepared alone and then mixed with coniferous sulphite in 75 to 25% proportion, respectively, and having 3% of melamine-formaldehyde resin added, would give paper equally as good, if not better, for offset printing (Fig. 8).

Black gum (tupelo) sulphate pulp (item 6): When this pulp was used in combination with 25% of sulphite (coniferous) and had 1 or 3% of bonding resin added, the papers made (runs 1503, 1516, 1517) were of good strength and had very high resistance to surface pick, but the expansivity was too high. The expansivity

of paper from run 1518, 100% of black gum sulphate pulp with 3% of bonding resin, was also too high (Fig. 9).

Since black gum sulphate pulp looks so promising in strength development and resistance to surface pick, it seems likely that if the pulp were combined with another hardwood pulp, instead of a coniferous, a very satisfactory paper could be obtained if 1 to 3% of bonding resin were used.

Peroxide-bleached paper birch groundwood (item 8): On the whole, in these papers (runs 1519–1521) the melamine resin had little beneficial effect.

Paper birch sulphite pulp (item 10): Papers (runs 1533–1535) with good strength and resistance to surface pick, combined with low expansion, were made from this pulp in combination with only 25% of sulphite pulp (coniferous) and having 1 or 3% of bonding resin added (Fig. 10).

Paper birch neutral sulphite pulp (item 9): As shown in the table the papers (runs 1508-1510) made

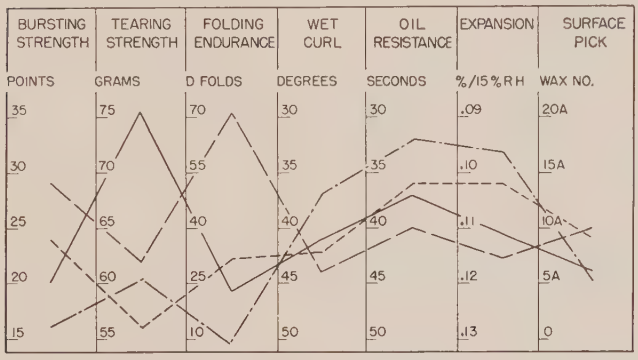

Fig. 8. Effect of melamine resin in papers containing aspen and spruce sulphate pulp (FPL item 3)

— 1499, blank, 100% bleached sulphate, 67% aspen, 33% spruce; — — 1500, 1% M, 100% bleached sulphate, 67% aspen, 33% spruce; — · — 1501, blank, 60% bleached sulphate (67% aspen, 33% spruce), 40% strong soda; – – – – 1502, 1% M, 60% bleached sulphate (67% aspen, 33% spruce), 40% strong soda.

from this pulp and varying percentages—25, 50, and 75, respectively—of soda pulp (hardwood) without bonding resin added were unsatisfactory because of very high expansivity and curl.

Beech sulphate pulp (item 12): Beech sulphate was another pulp from which papers (runs 1568–1570) were produced with satisfactory strength and resistance to surface pick, combined with low expansivity, when 1 or 3% of melamine-formaldehyde resin was added. Drastic beating alone did not develop the necessary strength in the paper (run 1571). Moreover it increased the expansivity above that of the paper in which bonding resin was used, and reduced tearing strength and air permeability (Fig. 11).

Douglas-fir neutral sulphite pulp (item 13): This is a coniferous wood pulp whereas the other pulps supplied by Forest Products Laboratory were wholly or predominantly hardwood. The papers (1529–1531) made from the Douglas-fir pulp mixed with soda pulp (hardwood)—25, 50, and 75%, respectively—without bonding resin, were fairly satisfactory, but the expansivity was approximately the maximum allowable.

Since a long-fibered pulp characterized by high strength, especially tearing resistance, was produced from Douglas-fir by the neutral sulphite, semichemical process, it seems that the wood might better be cooked by one of the other pulping processes. It would thereby make available long-fibered, softer pulp which

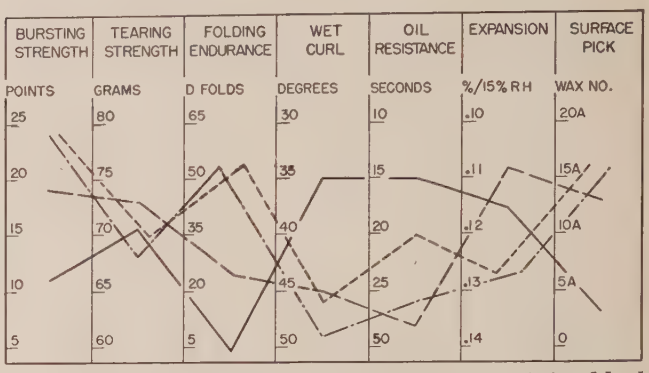

Fig. 9. Effect of melamine resin in papers containing black gum sulphate pulp (FPL item 6)

— 1503, blank, 75% bleached black gum (tupelo) sulphate, 25% eastern sulphite; — — 1516, 1% M, 75% bleached black gum (tupelo) sulphate, 25% eastern sulphite; — · — 1517, 3% M, 75% bleached black gum (tupelo) sulphate, 25% eastern sulphite; – – – – 1518, 3% M, 100% bleached black gum (tupelo) sulphate.

would doubtless be satisfactory for use with such hardwood pulps as have been used in these experiments, and release the spruce sulphite pulp (coniferous) for other types of papers. Douglas-fir appears to show great promise as a wood for papermaking.

Other hardwood-coniferous pulp mixtures: To afford comparisons two series of papers were made from a furnish of commercial bleached soda pulp (hardwood)

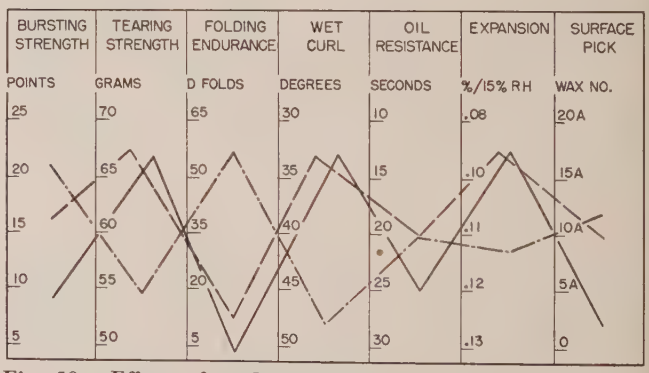

Fig. 10. Effect of melamine resin in papers containing paper-birch sulphite pulp (FPL item 10)

— 1533, blank, 75% bleached paper-birch sulphite, 25% bleached eastern sulphite; — — 1534, 1% M, 75% bleached paper-birch sulphite, 25% bleached eastern sulphite; — · — 1535, 3% M, 75% bleached paper-birch sulphite, 25% bleached eastern sulphite.

and commercial sulphite pulp (coniferous), without and with melamine resin. For one series (runs 1562–1564) 75 and 25% of the pulps, respectively, were used (Fig. 12); for the other series (1540, 1560, 1561) 50% of each was used (Fig. 13).

SUMMARY

Promising results were obtained with the hardwood

pulps alone and mixed in the production of lithographic-type papers. Papers with good strength and resistance to surface pick, combined with low expansion and curl, were made from the hardwood pulps with melamine-formaldehyde resin added for bonding. By use of the resin (1 or 3%, based on dry fiber) the paper could be made from a less hydrated stock, the strength being developed mainly by bonding the fibers

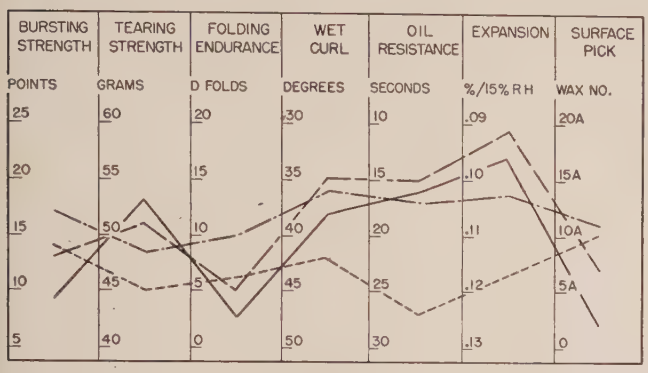

Fig. 11. Effect of melamine resin in papers containing beech sulphate pulp (FPL item 12)

— 1568, blank, 75% bleached beech sulphate, 25% bleached eastern sulphite; — — 1569, 1% M, 75% bleached beech sulphate, 25% bleached eastern sulphite; — · — 1570, 3% M, 75% bleached beech sulphate, 25% bleached eastern sulphite; - - - - 1571, blank, longer beating time.

with the resin instead of by the conventional beating. The pulps giving particularly promising results comprised aspen sulphate, aspen soda, aspen sulphite, birch sulphite, and black gum sulphate. The qualities of the papers made from these pulps are as good as, and in some respects better than, those of paper made from 50% commercial hardwood pulp and 50% commercial sulphite softwood pulp.

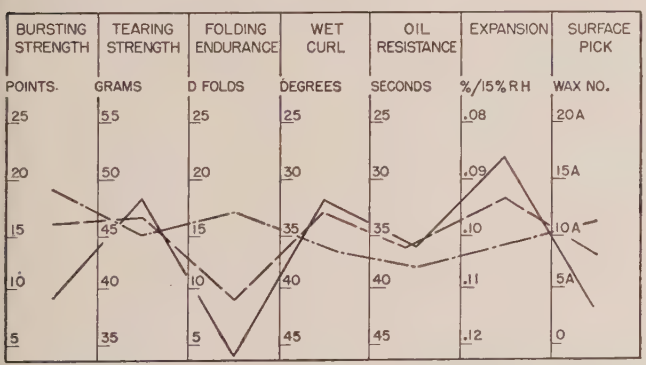

Fig. 12. Effect of melamine resin in papers containing Douglas-fir neutral sulphite pulp (FPL item 13)

— 1562, blank, 75% strong soda, 25% eastern sulphite; — — 1563, 1% M, 75% strong soda, 25% eastern sulphite; — · — 1564, 3% M, 75% strong soda, 25% eastern sulphite.

Although not a hardwood, Douglas-fir was also included in the study to evaluate its papermaking characteristics. Only neutral sulphite (semichemical) pulp was used but since the fibers were long and seemed to have high strength, especially tearing resistance, it is believed that if the pulp were prepared by any of the other chemical processes an excellent papermaking material could be produced. In general, papers made from the pulps prepared from any of the woods by the neutral sulphite (semichemical) process were not entirely satisfactory. The pulps tended to hydrate too quickly and to develop considerable hardness, and the papers made from them had high expansivity and curl.

An example of the possibilities of resin bonding used to develop strength in papers made from hardwood pulps is shown by the measurements obtained on the papers made from 75% bleached aspen sulphate and

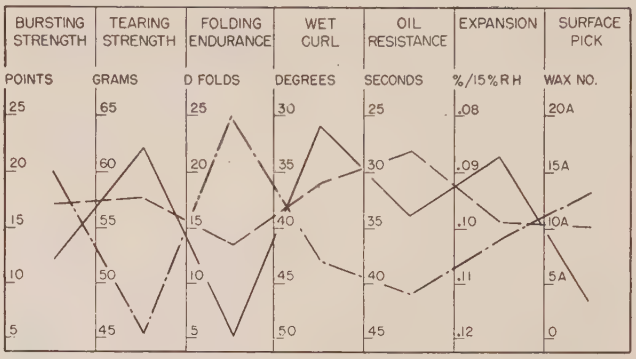

Fig. 13. Effect of melamine resin in papers containing commercial hardwood soda pulp and coniferous sulphite pulp

— 1540, blank, 50% bleached strong soda, 50% bleached eastern sulphite; — — 1560, 1% M, 50% bleached strong soda, 50% bleached eastern sulphite; — · — 1561, 3% M, 50% bleached strong soda, 50% bleached eastern sulphite.

25% commercial sulphite pulp. With all other factors constant, the addition of 3% melamine-formaldehyde resin to this fiber furnish increased the bursting strength from 8 to 22 points, the folding endurance from 2 to 46 double folds, and the resistance to surface pick from wax 2A to 13A, yet the expansivity remained low. These results were obtained without beating the fibers to any considerable extent.

Judged by the laboratory test data the results appear very satisfactory. The performance of the experimental papers in the printing operations, however, will be the determining factor in their satisfactoriness for lithographic use.

Printing tests of them are being made in the experimental printing plant of the Lithographic Technical Foundation and the results will be published by the Foundation. If they are satisfactory, the development of strength through the use of synthetic resins in offset papers may greatly increase the use of hardwood fibers.

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Relation of Red Slimes to General Paper Mill Slime Control

J. R. SANBORN

The occurrence of various types of slime growths over the past 20 years is shown graphically. The occurrence of red slime has become increasingly important as other types of organisms are brought under control. The effect of the development of slime treatments on the occurrence of types and frequency of various organisms is discussed. Some types of organisms apparently follow a cycle of occurrence. The elimination of slime is only one step in the prevention of undesirable deposits in a mill system. A well-integrated program is necessary to insure clean systems.

DURING the past two decades 356 mills of all types have participated in an investigation to determine conditions which encourage "nuisance" growths in pulp and paper systems and to develop suitable methods of control. In mill operations, slime-forming microorganisms are among the most troublesome, particularly the red or pink slimes which are unusually persistent.

Red slimes are produced by a variety of different microbiological groups. In this cooperative study, 100 representative outbreaks at 65 mills in the United States and Canada have been investigated. These cases produced 320 isolations of red slime-forming bacteria and fungi belonging to 20 different groups, present proportionally as follows:

	Relative proportions of principal groups in red slimes, %
Sporeforming and nonsporeforming bacteria (*Bacillus, Serratia, Micrococcus*, etc.)	19
Yeastlike fungi (*Rhodotorula, Monilia, Monascus*, etc.)	60
Mold-type fungi (*Cephalothecium, Fusarium, Ascochyta*, etc.)	21

While certain organisms included in the foregoing are well known, others are still incompletely described. Harrison (*1*), in his historical account entitled "The 'Miraculous' Micro-organism," has reviewed the religious background in medieval Europe attending appearances of the "bleeding host." Later, the causal organism of "bloody bread" and similar red discolorations was discovered and named *Bacillus prodigious*, now called the *Serratia marcescens* group (*2*). Harrison (*3*) has also added to our knowledge of the so-called "pink yeasts," i.e., the genus *Rhodotorula*. A general review of the yeastlike fungi with an extensive bibliography is provided by Skinner (*4*).

Red-pigmented varieties of the *Bacillus subtilis* group and related organisms are discussed in the authoritative works of Gibson (*5*) and Smith (*6*).

Despite the instability ascribed to certain groups and the variable effects of different temperatures, air supply, available food, etc., on pigmentation, there is nothing vague or indefinite about an upsurge of red slime. While more or less confusion exists in academic circles concerning red varieties, mills have been doing something concrete toward understanding and controlling the outbreaks.

From the standpoint of practical control, color is incidental to the physical properties of slime which renders the growths adherent, impervious, and stable. Furthermore, red colorations sometimes result from associations of growths that are not, in themselves, pink or red. Besides, so-called red slimes are not always red. Some turn from brown to brick red, others from deep red to black. It may be helpful, therefore, to review mill experience and microbiological trends in the control of all troublesome types of slime.

MILL OBSERVATIONS

The physical forms which mill slimes assume, e.g., rubbery sheets, string, rope, granules, globules, etc., are determined by the growth characteristics of the causal organism growing in favorable locations or breeding places. Certain gelatinous slimes spread quite generally over exposed surfaces; others, including numerous red growths, develop in out-of-the-way places, stagnant spots, and in locations that are virtually subsurface. Among the latter growths are varieties described as compact, adherent, rubbery, or hard, usually found in localized areas. Mill men have noted the tendency of red slimes to persist in relatively inaccessible places without necessarily causing trouble. Scrapings from flow boxes, paper machine trays, sides of suction boxes, groundwood canals, savealls, and deposits at screens frequently yield compact, pigmented growths. Where incipient red slimes persist such samples usually reveal the presence of the causal organism well in advance of an outbreak, e.g., red organisms have been detected in mill systems from 1 to 3 years prior to an upsurge. As long as favorable breeding places remain eventual trouble is virtually inevitable. Mill operators are already familiar, from first-hand observation, with numerous correlations between the various forms of slime and specific locations in mill systems. Observations of this kind are important to successful control. The work of Ferguson et al. (*7*) is illustrative of the valuable contributions that mill men are making to practical slime control.

TRENDS AMONG PRINCIPAL SLIME FORMERS

A review of trends among members of a diversified slime flora during the past 20 years, comprising some 5200 isolations, reveals three fairly distinct periods of gradual but noticeable change. These periods may be distinguished for purposes of discussion according to microbiological conditions of (a) balance (1930–37), (b) selection (1938–46), and (c) resistance (1947–50).

Balance Among Microorganisms, 1930–37

Prior to 1938 the principal types of microorganisms

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established in mill systems, considered proportionally, probably represent fairly closely conditions that were obtained before general application of control programs. The slime flora of 15 or 20 years ago showed considerable repetition of similar species and varieties growing together throughout the year in a manner that suggests a state of bálance among these organisms and their associates. Little decisive evidence could be observed of outstanding domination by any one group over the others. During this period, the red slimes appeared to encounter difficulty in becoming established and only scattered outbreaks were reported, caused mainly by the so-called pink rot fungus *Cephalothecium roseum,* frequently found on lap stock, and by strains of the nonsporeforming pink yeasts, i.e., *Rhodotorula.*

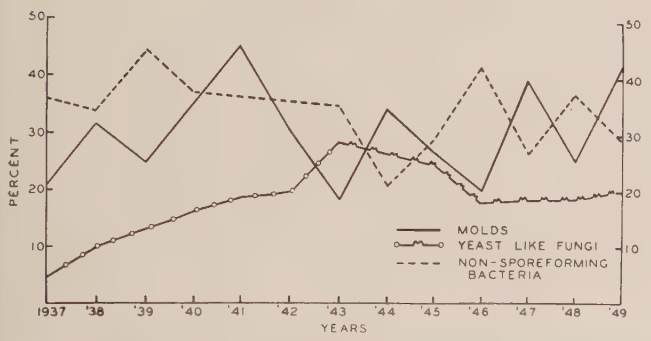

Fig. 1. Trends among principal microbiological groups, 1937–49 (percentages of total isolations)

The early flora naturally contained groups which later proved susceptible to chemical reagents. As these groups were "weeded out," more persistent and resistant slimes became selectively dominant. Use of chlorine and copper sulphate, the most commonly used chemicals at that time, controlled or inhibited certain kinds of microorganisms, but many different species and varieties withstood these treatments.

Consequently some of these resistant groups of slime-forming microorganisms increased by as much as 40 to 150%. Other types were either suppressed or eliminated. While there is no implication that this selective activity resulted necessarily in more serious conditions than before, the problems were unquestionably different.

Domination by Selected Groups, 1938–46

Beginning about 1938 certain individual groups of microorganisms became predominant for short or longer periods. From 1940 to 1943, coliform slimes were among the most prevalent and abundant. Slimy varieties of *Oidium (Oospora) lactis,* which attained considerable importance during these years, rapidly decreased in 1943 followed by upsurge of other yeastlike growths, including various species of monilia. Mucoid species of *Aspergillus and Penicillium* seemed to alternate for supremacy with the former apparently more abundant in the Spring and *Penicillium* in the Fall. Red slimes also reflected the general trend, particularly in the Spring and Fall months. The principal troublemakers among these organisms closely resembled the following groups: bacterial species *Micrococcus agilis, Serratia marcescens, Serratia piscatora;* the molds *Ascochyta spp, Gliocladium roseum, Penicillium pinophilum,* and *Fusarium spp;* and yeastlike fungi of the genera *Rhodotorula* and *Monilia.*

Specialized and Resistant Groups, 1947–50

Since 1946, the slime-forming flora has become even more highly diversified than in previous years. Certain fungus growths have assumed slime-producing properties and economic significance not heretofore associated with these particular groups. Recent isolations exhibit a high degree of resistance to heat and chemical reagents. A number of these organisms are resistant varieties of typical slime-producers well known, prior to control, for characteristically viscous formations. The red slime-formers, prevalent from 1946 to 1950, include varieties of sporebearing bacteria, yeastlike fungi, and members of the bacterial genus *Serratia,* closely resembling *Serratia piscatora* and *Serratia plymuthicum.* Several red-slime groups have recently been isolated from raw water and chlorinated fresh water which are sources of occasional contamination.

While the slime flora of mills is properly considered essentially plantlike, at least one mill has reported a major slime condition at fresh water intake screens caused by a definite animal form identified as one of the Bryozoa or moss animals. Large, circular, compact, translucent growths developed which completely stopped the flow of water through the screens.

Results for the year 1950 have not been completely tabulated, but it is quite possible that another period of change may now be under way. The 1950 flora is less diversified than that of 1949 and contains fewer specialized types of fungi. According to present indications the principal growths in 1951 may be those produced by nonsporeforming bacteria and yeastlike fungi.

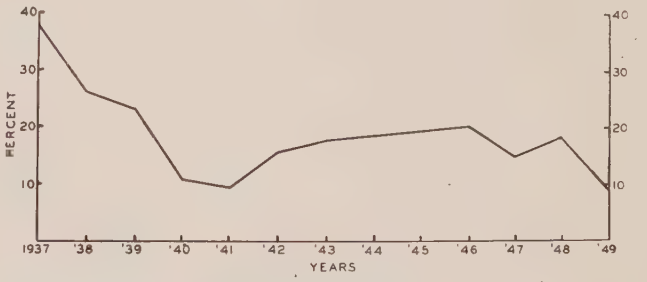

Fig. 2. Fate of sporeforming bacteria, 1937–49 (percentages of total isolations)

Mold slimes are likely to increase spasmodically but good control of sporeforming bacteria will undoubtedly continue.

Microbiological Cycles

The foregoing comments suggest that the slime situation in mills is never static. Slime-forming groups are subject to frequent variations (*8*) that are aggravated by changes in mill operations and chemical treatments. Study of trends in the principal flora of mills over a period of years suggests that certain groups reoccur with sufficient regularity to indicate that variations follow more or less definite cycles. Several mills reported, years ago, that winter slimes were stringy or fluffy and summer slimes compact. Investigations showed that

the winter slimes were mixtures of gelatinous growths of fungi and stringy growths produced by sporeforming bacteria. The compact slimes, formed by yeastlike fungi and certain molds, are gummy, rubbery, or hard. Alternately, coliform slimes virtually replaced the stringy, gelatinous fungi during late winter and spring, forming, with yeastlike fungi, viscous, ropy, compact, or membranous slimes. Microbiological patterns vary with the year and with the type and location of the mill. For many years cyclic changes were used successfully in predicting periods of slime upsurge and the probable character of the growths, as well as a guide to procedures for preventing trouble.

Slimes which formerly prevailed during the Fall months sometimes determined the character of the growths that developed in late Winter and Spring. It is apparently true also that Summer slimes occasionally reappeared the following Spring when rising temperatures encouraged slime-forming groups that were previously dormant. Numerous slow-growing slimes which are characteristically compact, often pigmented, and almost always troublesome, are typical of many conditions that develop from May to July. Summer slimes are usually, but not always, quite different from previous formations. Changes such as the foregoing are markedly influenced by proper timing of chemical treatments. Mills that have come to expect trouble during definite periods, can, through planned programs based on proper timing, prevent or mitigate slime upsurge. Thus, through adoption of preventive programs, microbiological cycles have been, in large measure, disrupted.

Figures 1 and 2 show general trends among major groups. Comparison of trends in the incidence of molds and nonsporeforming bacteria indicates that these groups occur in inverse ratio, a relationship variously confirmed in practice. Where the two groups develop simultaneously, the molds usually grow quite independently of the bacteria. On the other hand, molds such as *Mucor racemosus*, growing in fresh water systems, apparently thrive in association with certain nonsporeforming bacteria. In mill systems neither group appears to be seriously affected by the presence of yeastlike organisms. *Oidium* dominated the latter group from 1939 to 1943, designated in Fig. 1 thus, (-o-). Starting in 1963, *Oidium* was succeeded by other yeastlike fungi, chiefly *Monilia*, shown in the foregoing figure, viz. (-m-). From 1943 to 1947, pigmented varieties of all major yeastlike groups, including red, yellow, brown, and black growths, caused considerable trouble. Slime-producing varieties of sporeforming bacteria, particularly prevalent from 1937 to 1939, have been brought under satisfactory control.

CONTROL PROGRAMS

What can be learned from this review of mill experiences and microbiological trends that may serve as a useful guide for the future?

As far as control of slime-forming microorganisms is concerned, it seems clear that these diversified groups require a diversified program: one which (1) controls the primary causes of slime under conditions of actual mill operation, (2) gives lasting benefit rather than temporary relief, and (3) because of its flexibility affords the mill protection from periodic upsurges.

The main objective of slime control is to contribute to mill cleanliness. Practical mill cleanliness cannot, however, be accomplished merely by controlling microbiological growths. Accumulations consisting of fine fibers, pitch, resinous or oily masses, chemicals of furnish, foam, and corrosion products must also be considered. Any of these accumulations can harbor living organisms and provide sources of continuous inoculation of mill systems. Slime control should, therefore, be used not as an end in itself, but as one of the steps in producing mill cleanliness. Since all of these conditions influence slime control it is usually impossible to produce a clean mill without correcting all of the basic causes of accumulation which are inseparably connected with operating conditions.

General Cleanliness

It is only natural that emphasis be placed on chemical treatments for removal and prevention of all such deposits in mill systems. Regular and systematic programs of mechanical cleaning will help reduce costs and improve results. A mill executive recently stated: "We clean for the same reason a man takes a bath every day. If he doesn't, other people know it before he does." Actually, no mill should wait for customer complaints before adopting and following a rigid control program.

Microbiological Control

Microorganisms can enter a mill system from many sources including fresh water which is of primary importance. Chlorination of any fresh water containing microorganisms is desirable. Fresh water may also need clarification or even softening to make it clean by eliminating undesirable characteristics. For recirculated white water the more lasting chlorophenolic treatments will control all important groups of troublesome organisms. While microorganisms causing red slimes comprise currently only about 8.8% of the total slime-forming flora, they are much more troublesome than this percentage would indicate because these growths contribute to more complex, viscous, and rubbery slime formations. Successful control of all such organisms depends mainly on proper timing of application of certain types of chlorophenolic chemicals that have proved to be most effective for this particular class. It is necessary, therefore, that the program relating to slime control treatment be flexible and subject to change as needed.

In order to assist the slime control program by eliminating other accumulations, a study should be made of pitch deposits and the possible use as a remedy of blended polyphosphates. Improved retention of sizing chemicals and chemicals of furnish often results in less deposit. Reduction in fine fibers in the white water and general clarification of these supplies by proper treatment are also helpful. Areas or conditions of stagnation should be "ferreted out" and reduced to a minimum. Foam frequently promotes microbiological growths and forms other deposits which should be controlled. Numerous types of microorganisms either cause or aggravate corrosion. It is essential, therefore, that programs of control include prevention of biological corrosion and elimination of corrosion products.

The increased incidence of red slimes in past years has

taught us more than anything else how necessary it is to consider slime control and the elimination of mill accumulations under one complete integrated program. This problem has also shown that any program of slime control cannot be restricted and inflexible like a straight jacket, but must be subject to change and flexibility depending upon the specific problems being encountered due to climatic changes, variation in the water supply, cyclic changes from year to year and upon the materials used in the furnish as well as other conditions of mill operation. Until such a program is studied and formulated, adopted, and rigidly followed, flare-ups of slime or other deposits can be expected.

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The Mechanical Behavior of Paper—Part I

GEOFFREY BROUGHTON and N. A. MATLIN

Much work has been done in the past on the mechanical behavior of paper including its stress-strain behavior. In most cases, however, rate of elongation was not constant. In the present investigation, load-elongation curves were measured at constant rates of elongation, varying from 0.02 to 2 inches per minute using the Instron tensile tester. Results are presented for a number of different papers including handsheets and machine-made papers. The data have been studied and some tentative correlations are presented.

This paper results from a series of experiments intended to explore and more completely define the ground for future, more detailed work. The behavior of paper under mechanical stress, in particular tensile strength at break, has been the subject of many previous investigations (*5*, *7*). The introduction of modern electronic stress recording devices is now stimulating work in this field because they permit more accurate determination of the stress-strain diagram than ever before with less effort and greater rapidity. Furthermore, measurements can be made at a constant rate of elongation with the Instron tensile testing instrument used in the present investigation.

EXPERIMENTAL

All data presented in this paper were obtained on the Instron tensile testing machine. A detailed description of this apparatus is available in the literature (*3*).

The instrument consists essentially of two jaws, between which the specimen is clamped. The lower jaw is mounted on a crosshead which is driven at a constant speed by two worm gears. The latter are coupled to a motor through a linkage in which change gears may be inserted. Change gears are available which give eleven rates of elongation, varying from 0.02 to 20 inches per minute.

The upper jaw, for all practical purposes, is a stationary member directly connected to an electronically operating strain gage. Strain gage cells are available capable of measuring loads from a few grams to several thousand pounds per square inch. The strain gage through an electronic system and motor, operates a pen which records on a moving chart. The chart itself is coupled through a gear linkage to a reversible synchronous motor. Various change gears may again be used to give a chart speed equal to the crosshead speed or to any of several multiples or submultiples of it. The distance between the jaws may be set at any length within the mechanical limits of the machine. These arrangements allow the determination of a simple stress-strain diagram, automatic cycling of a specimen between any desired limits of load or elongation, or measurement of stress relaxation at any desired elongation.

Conditions were maintained at 65 ± 5% R. H. and 70 ± 2°F. A distance of 2 inches between flat-faced

Table I

	Kraft A		*Copy A*		*Rag 4-A*	*Rag 4-B*	*Kraft 5-B*
	Machine	*Cross*	*Machine*	*Cross*			
Symbol	KAM	KAC	CAM	CAC	R4A	R5B	K5B
Fibers	Unbleached kraft, groundwood		Sulphite, rag		Rag	Rag	Bleached kraft
Manufacture	Commercial		Commercial		Handsheets		Handsheet
Basis weight, lb./1000 sq. ft.	14.5		7.15		25.2	34.3	28.2
Thickness, $^1/_{1000}$ in.	4.4		1.9		9.7	8.5	8.0
Freeness, Williams, sec.	...	...	...	...	19.6	98.4	107.3
Solid fraction	0.422		0.482		0.333	0.512	0.452
Initial cross-sectional area, $^1/_{1000}$ sq. in.	1.6	1.6	0.7	0.7	3.6	3.2	3.0
Cross-sectional area at break, $^1/_{1000}$ sq. in.	1.6	1.5	0.7	0.7	3.5	3.1	2.8

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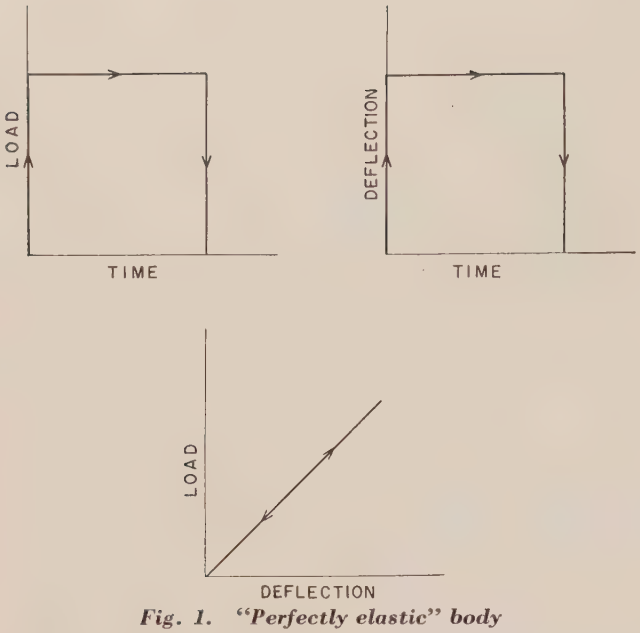

Fig. 1. "Perfectly elastic" body

jaws was used. Samples were razor-cut to 3/8 inch width. Table I lists the properties of the five different papers tested at constant rates of elongation of 0.02, 0.05, 0.1, 0.2, 0.5, 1, and 2 inches per minute.

It should be noted that none of the handsheets contained any sizing.

The higher speeds available on the Instron, 5, 10, 12, and 20 inches per minute, were not used because the machine has a definite time lag. The strain cell is capable of a response which is satisfactory but the recorder pen possesses a speed of response which is not entirely suitable for all work. The manufacturer's instructions state that the stress-strain curve produced on the chart will have an error of 1% or less of full scale if 5 seconds or more are consumed in pen travel from zero to the edge of the chart.

Table II. Number of Samples Run to Break

Rate of elongation in./min.	*KAM*	*KAC*	*CAM*	*CAC*	*R4A*	*R4B*	*K5B*
0.02	11	12	15	15	15	14	15
0.05	10	15	14	14	15	15	15
0.1	11	14	14	15	15	15	15
0.2	10	15	14	17	15	16	15
0.5	11	15	16	14	15	15	15
1.0	10	15	15	15	15	15	14
2.0	11	15	15	15	15	15	15

The writers have found that in using a 2-inch gage length, speeds of greater than 2 inches per minute give false curves with the papers tested. The time necessary for any sample to be extended from a relaxed state to the point of rupture depends upon the inherent elongation of the paper tested. Therefore, for papers with a high ultimate elongation or in using a large jaw-to-jaw distance, or for both cases, higher speeds may be used. Any person contemplating the use of the Instron for paper testing should be warned, therefore, that trial runs and calculations must be performed to determine the safe upper limit of rate of elongation.

The chart magnification was 10× in all cases. Table II lists the number of samples run to break for each paper and speed. All data from jaw breaks were discarded.

THE STRESS-STRAIN CURVE

Tensile strength and elongation at break have long been used in paper specifications and in textile work. In recent years, in both fields, attention has been directed to a consideration of the complete stress-strain curve rather than to an evaluation of the rupture point alone (*5, 6*).

If a load is applied to a material, a deformation occurs, part of which is instantaneous and part of which may take place over a period of time. The first is termed immediately recoverable deflection or "elongation." The deflection which occurs over a period of time may be divided into two components—recoverable deformation or primary creep, and nonrecoverable deformation or secondary creep. It should be noted that secondary creep is defined as deformation not recoverable under the stated test conditions. Therefore, if a sufficiently long period of time were allowed for the removal of load, all deformation might be recoverable. The distinction between primary and secondary creep is therefore probably one of degree, not of type.

If paper were a "perfectly elastic" material, such as steel, the rate of elongation used in tensile testing would be of little importance for loads below the elastic limit. For "perfectly elastic" materials the shape of the load deflection curve for loads below the elastic limit is always rectilinear, irrespective of elongation rate. Figure 1 illustrates such behavior.

Paper is however, an "imperfectly elastic" body. It will be seen in Fig. 2 that the load-time relationship is the same as that for steel wire, but the deflection-time curve obtained upon applying a load is entirely different.

First, there occurs an immediate deformation followed by a delayed deformation, the rate of which decreases with increasing time. Upon removal of load, an instantaneous contraction takes place, equal in magnitude to the immediate deformation caused upon initial application of load. A slow subsequent contraction occurs which, in the ordinary test, is never complete, due to the permanent stretch or secondary creep.

Repeated application and removal of load, i.e., cycling, will, for all practical purposes, remove secondary creep. This process is known as mechanical conditioning.

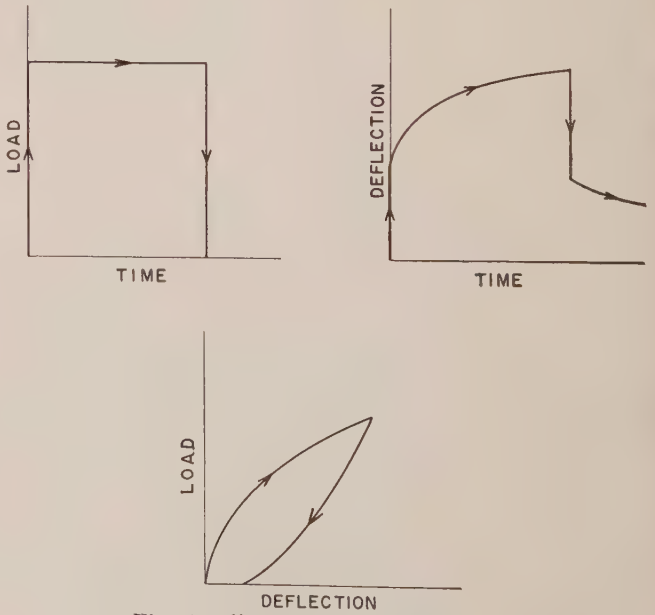

Fig. 2. "Imperfectly elastic" body

Table III. Corrected Tensile Strength
Pounds per Square Inch Cross-Sectional Area at Break/Solid Fraction

Rate of elongation, in./min.	*KAM*	*KAC*	*CAM*	*CAC*	*R4A*	*R4B*	*K5B*
0.02	12,800	4830	13,700	6760	6340	7840	16,200
	±600	±230	±1,000	±490	±560	±500	±1,500
0.05	13,600	4830	14,100	6840	6820	7500	16,500
	±900	±370	±700	±470	±450	±940	±1,500
0.1	13,500	5020	15,200	6880	6730	8220	17,600
	±900	±250	±1,400	±710	±780	±970	±1,500
0.2	14,000	5070	16,000	6990	6790	8080	16,900
	±900	±340	±1,100	±320	±1120	±850	±1,500
0.5	14,100	5160	16,600	6780	6610	8000	18,800
	±900	±300	±1,200	±470	±670	±900	±1,900
1.0	14,800	5430	16,600	7180	7000	7820	18,200
	±1,500	±260	±1,100	±490	±780	±970	±700
2.0	14,700	5450	16,500	7510	7150	8240	18,200
	±900	±340	±1,500	±710	±670	±970	±1,500

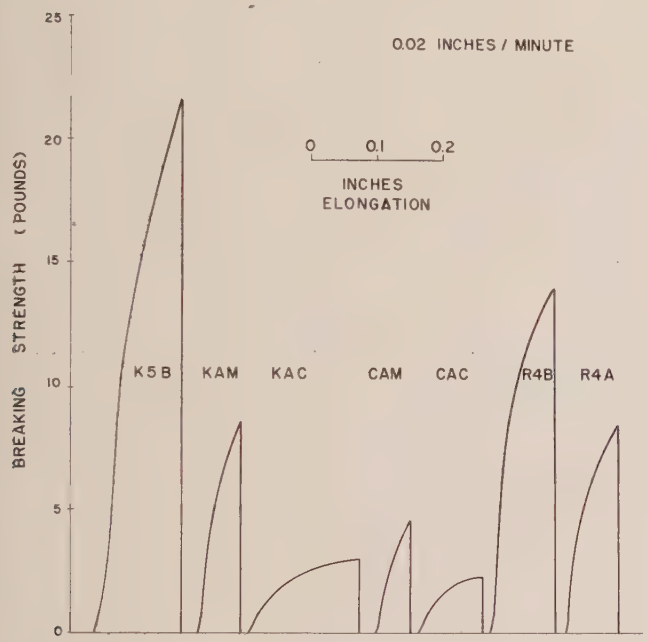

Fig. 3

sample, three values may be directly obtained. They are the breaking strength in pounds, the elongation at break in inches, and the energy absorption capacity or work to break in inch-pounds. The first two are read directly from the coordinates of the rupture point. The third is represented by $\int_i^R FdE$ which is the area beneath the stress-strain curve. It is obtained by use of a planimeter. To enable a truer comparison among the several papers, and to decrease the number of variable conditions, three corrections of the data were carried out.

First, the absolute elongation was calculated to a percentage basis.

Second, the breaking strength and work to break were referred to the cross-sectional area of the paper at break (*2*), according to the equation:

$$A_b = A_i \cdot \frac{l_0}{l_0 + e}$$

in which A_b is the cross-sectional area at break, A_i is the initial cross-sectional area, l_0 is the original length of the sample, and e is the elongation in inches of the sam-

Table IV. Elongation at Break (Per Cent)

Rate of elongation, in./min.	*KAM*	*KAC*	*CAM*	*CAC*	*R4A*	*R4B*	*K5B*
0.02	3.80	7.70	3.40	4.85	3.30	4.30	5.80
	±0.20	±0.50	±0.75	±0.75	±0.75	±0.50	±0.75
0.05	3.30	7.75	3.65	5.50	3.65	3.85	5.40
	±0.20	±1.10	±0.35	±0.50	±0.55	±0.95	±0.75
0.1	3.45	7.80	3.55	5.10	3.45	4.15	5.40
	±0.30	±0.90	±0.20	±0.75	±0.75	±0.75	±0.55
0.2	3.25	7.20	3.55	4.50	3.50	4.15	4.90
	±0.20	±0.90	±0.20	±0.60	±0.75	±1.00	±0.75
0.5	3.25	7.60	3.60	4.75	3.55	4.40	5.25
	±0.30	±0.90	±0.20	±0.70	±0.55	±0.55	±0.55
1.0	3.20	8.10	3.50	4.35	3.60	3.85	5.10
	±0.30	±1.10	±0.20	±0.55	±0.75	±0.95	±0.35
2.0	3.00	7.95	3.35	4.05	3.60	3.40	4.95
	±0.15	±1.10	±0.35	±0.55	±0.55	±0.75	±0.75

In the present investigation, samples dealt with in this section were run to break without cycling. Typical curves for the papers tested are illustrated in Fig. 3.

The term "elongation" will henceforth be considered to include all components of strain—immediate and delayed.

DATA AND CALCULATIONS

From each stress-strain curve produced by running a

ple. The assumption was made that a sample remains constant in density during elongation.

The third correction was first suggested by Doughty (*1*). This is the correction of tensile values for the solid fractions of the different paper sheets.

Solid fraction is defined as the ratio of fiber volume to sheet volume. Therefore, it is also the ratio of sheet density to fiber density. Doughty determined the density of cellulose fibers as 1.5 grams per cubic centimeter.

Table V. Energy Absorption Capacity

Inch-Pounds per Square Inch Cross-Sectional Area at Break/Solid Fraction

Rate of elongation, in./min.	*KAM*	*KAC*	*CAM*	*CAC*	*R4A*	*R4B*	*K5B*
0.02	426	514	428	407	253	441	1120
	±47	±46	±78	±94	±90	±140	±260
0.05	445	526	442	475	299	363	1010
	±57	±120	±76	±61	±67	±138	±220
0.1	464	540	481	444	276	428	1080
	±72	±108	±90	±108	±82	±120	±150
0.2	452	510	510	394	300	428	978
	±72	±90	±90	±84	±112	±132	±232
0.5	458	542	514	423	282	390	1140
	±72	±108	±97	±104	±82	±127	±220
1.0	492	595	500	409	330	349	1080
	±81	±123	±78	±86	±112	±108	±140
2.0	466	597	460	388	312	340	1030
	±54	±123	±94	±86	±90	±123	±260

Calculations in the present work were based on this value.

Tables III, IV, and V list, respectively, corrected tensile strength, per cent elongation at break, and corrected energy absorption capacity. The mean values and standard deviations are given.

Figure 4 represents the variation of corrected tensile strength with rate of elongation for the papers tested.

It has been found in the textile field that tensile strength is a logarithmic function of the rate of loading (*4*). There is some indication with paper, over the range of elongation rates investigated, that a similar relationship exists here between tensile strength and rate of elongation. There is some increase in tensile strength with increasing rate of elongation, but the differences between any two consecutive values on a given paper do not appear to be statistically significant.

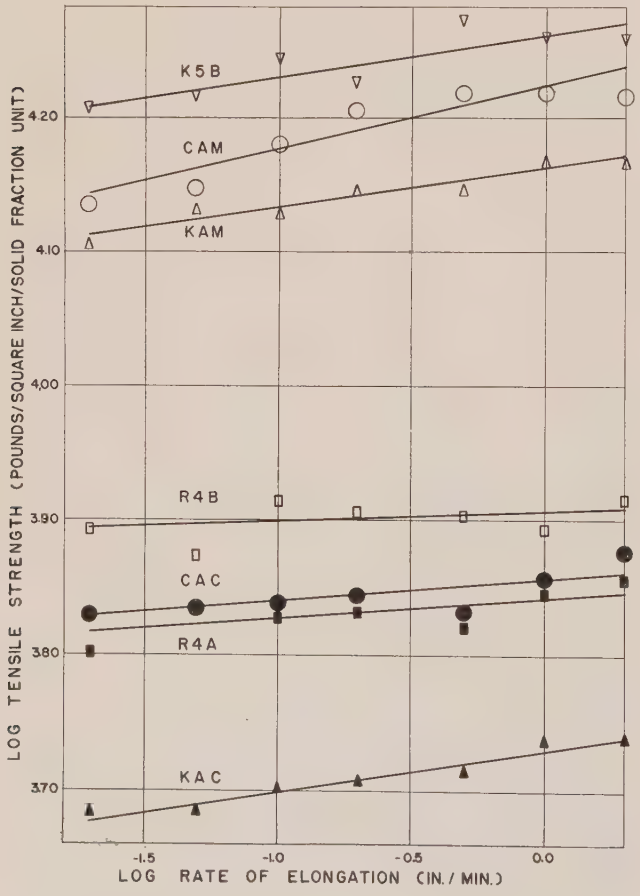

Fig. 4

Figure 5 depicts the effect of rate of elongation upon elongation at break.

Here too trends are indicated, but the evidence of statistically significant differences is slight.

Figure 6 illustrates the relationship between rate of elongation and energy absorption capacity, or work to break, for the various papers.

The rate of elongation appears to have the same effect upon work to break as it does upon tensile strength and elongation.

DISCUSSION

Curves for all three variables may be represented by the general equation:

$$\text{Variable} = k(dE/dt)^{\pm m}$$

m was always found to be less than 0.1. k will be seen to be the value of the variable at an elongation rate

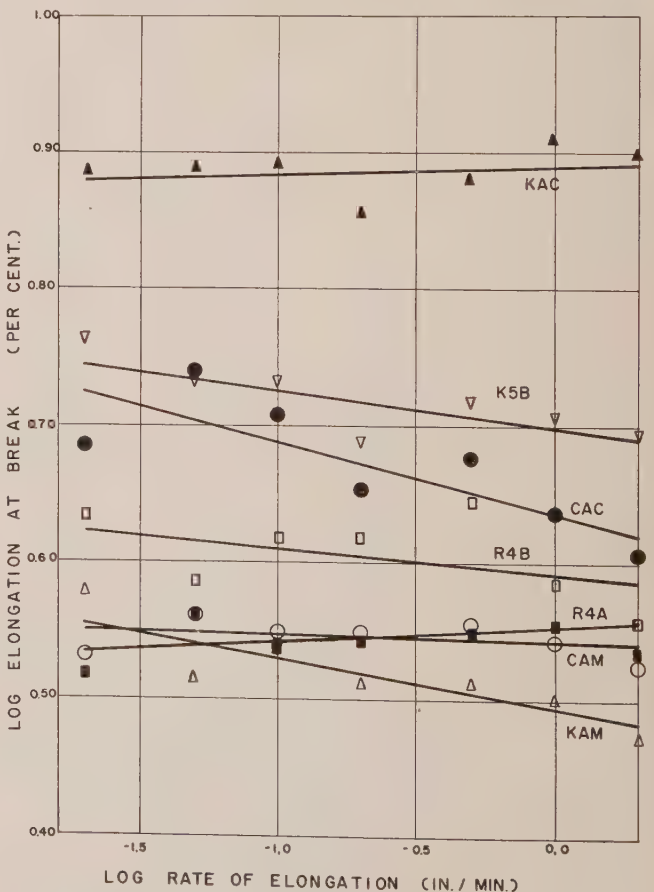

Fig. 5

Table VI. Values of k and m

	KAM	KAC	CAM	CAC	R4A	R4B	K5B
			(Tensile Strength)$_{corr.} = k(dE/dt)^m$				
k:	14,600	5340	16,800	7150	6920	8060	18,200
m:	0.0289	0.0301	0.0475	0.0150	0.0140	0.0070	0.0305
			(Elongation at Break)% $= k(dE/dt)^m$				
k:	3.13	7.72	3.49	4.31	3.58	3.90	5.00
m:	−0.0356	0.0055	−0.0047	−0.0527	0.0110	−0.0192	−0.264
			(Energy Absorption Capacity)$_{corr.} = k(dE/dt)^m$				
k:	470	566	501	399	310	369	1060
	0.0193	0.0300	0.0285	−0.0267	0.0358	−0.0426	0.0041

of 1 inch per minute. All efforts at correlating m with physical properties of the sheets have failed. Table VI lists the values of k and m in the equations relating rate of elongation with corrected tensile strength, per cent elongation at break, and corrected energy absorption capacity.

One is moved to the conclusion that, at least within the range of speeds indicated—which give a hundredfold spread—the tensile strength, elongation at break, and work to break, are functions of the rate of elongation, but that the functions are such that no practical or marked effect upon the variables is discerned.

Two stress-strain curves are represented in Fig. 7. The curves were produced by cycling two twisting papers and then breaking them after 5 cycles. On the chart, only the first and fifth cycles are shown.

Twisting paper A has lower breaking strength than twisting paper B. It has, however, greater elongation at break and a greater total energy absorption capacity.

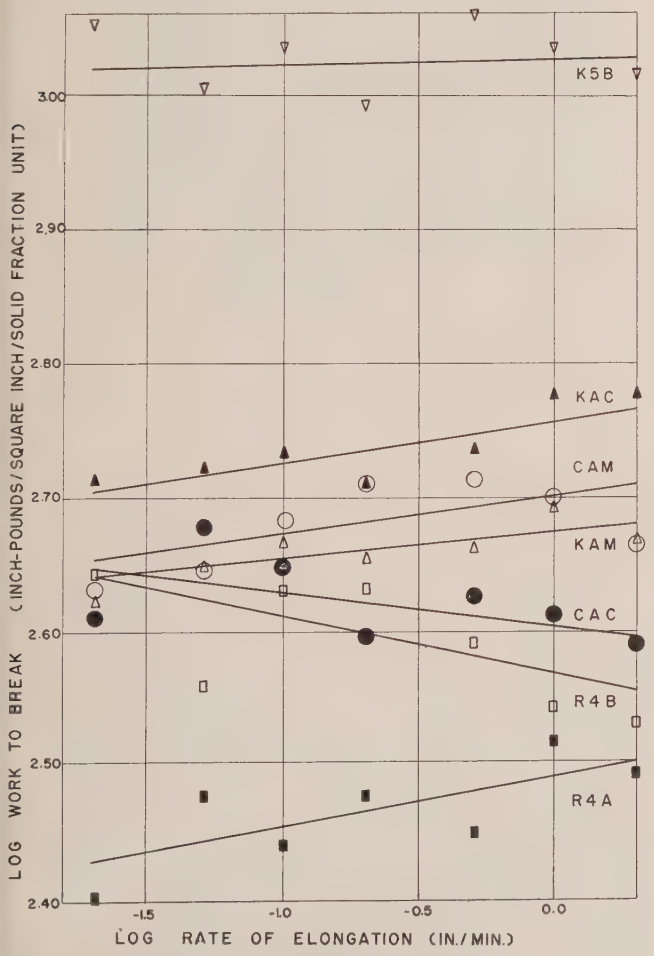

Fig. 6

At low elongations, i.e., up to about 50% of total elongation, twisting paper A absorbs more energy.

One practically important point has been reiterated by this investigation. Other workers have stated that materials which possess identical tensile strengths and elongations at break may vary greatly in regard to the work necessary to break them. The converse is also true.

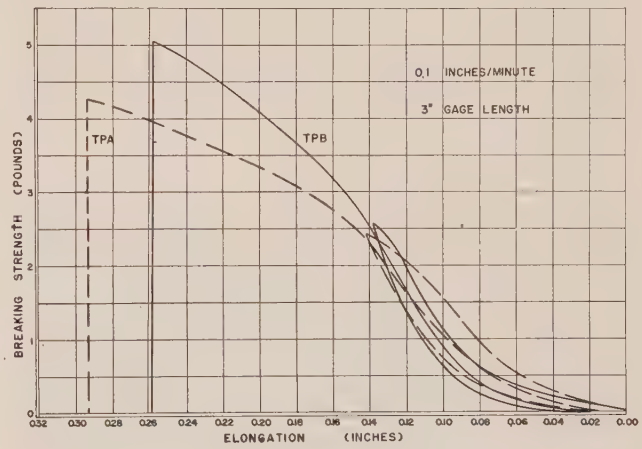

Fig. 7

This is as expected. Yet, above this point, until rupture, twisting paper B has the higher energy absorption capacity.

According to the end use of the product, therefore either A or B might be the superior paper. This should bring home the point that a comparison of specifications listing tensile strength and elongation at break does but little to tell of how the paper will stand up under a specific series of use stresses. It is therefore obvious that a knowledge of the entire stress-strain curve is necessary.

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Application of Enclosed Gearing in the Pulp and Paper Industry

F. RICHARDZ

This article touches lightly on the history and rapid growth of the pulp and paper industry and that the industry has always been and is progressive in its application of modern equipment. Enclosed gear drives are highlighted for use in the pulp and paper industry. Some of the main advantages of gear drives are enumerated with primary emphasis on efficiency, safety, reliability, and low maintenance cost. Standardization of gear drives by the gear manufacturers through the American Gear Manufacturers' Association is outlined with particular reference to industry application factors, output speeds, gear ratio, and lubrication. Gear motors and speed reducers are applied to various types of equipment in the paper industry; also illustrated is the use of modern high-speed gear drives to air-conditioning equipment. A brief sketch, covering history, present and future, is given of the gearing industry.

THE National Encyclopedia describes paper as "an aqueous deposit of vegetable fiber." According to history, prior to 1799, all paper was made by hand. Papermaking, like gearing, appears to be among the oldest of arts. It is reported that as early as 150 A.D., the Chinese were making pulp and paper from bamboo. They soaked the wood in pits of lime-water and separated the fibers by the impact of small stones on large flat stones. The pulp so produced was spread in thin layers and dried; the result being a sheet of paper.

In 1799, the first paper machine was invented in France by Nicholas Louis Robert. This machine was later perfected by two brothers, Henry and Sealy Fourdrinier of London, England, and, in 1803, the first fourdrinier paper machine was built at Bermandsey, England.

If the inventors of the original paper machine could see modern American machinery today, they would be very much amazed at the size, speed, and the improved product turned out. The American paper industry, according to statistics, has had a phenomenal growth. In 1899, only a little more than 90 years after the first fourdrinier machine was built, the pulp and paper industry in the United States employed approximately 49,500 wage earners and produced an approximate value of pulp and paper products amounting to $127,000,000. Thirty years later, the number of wage earners had increased by about 260% and the dollar value of pulp and paper produced increased by approximately 370%. From the middle of the 18th Century to the middle of the 19th Century, a period of 100 years, the number of wage earners increased in excess of 30 times and the "industry worth" in excess of 460 times. This statistical comparison does indicate that the industry has always been and is progressive and it also follows that the industry has availed itself of modern up-to-date equipment to the greatest extent. Gearing plays a very important part in the majority of modern equipment from the standpoint of dependability and efficiency—be it for small or large horsepower requirements, low-speed or high-speed applications.

The paper industry uses large quantities of electric motors as prime movers. These motors usually operate at higher speeds than required for the machines and, consequently, require some means of speed reductions. The most commonly used mediums for reducing the motor speed to a usable speed for the application are: belts, open gears, chains, enclosed gear reducers, and gearmotors. Enclosed gear drives provide many distinct advantages which may be summarized somewhat as follows:

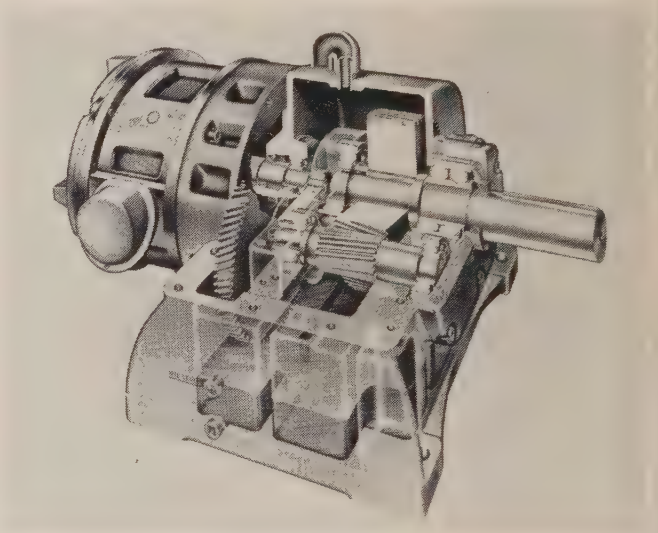

Fig. 1. Typical standard double reduction gearmotor of the horizontal type

1. High efficiency, as the gears are running in oil and generally the gear shafts are supported on antifriction bearings.
2. Compact in size, requiring a minimum of space.
3. Optimum safety, since the gearing is totally enclosed and essentially tamperproof.
4. Low maintenance cost, the main consideration being adequate lubrication.
5. Reliable operation, once properly installed and adequately lubricated, the gearing will usually outlast any other power transmitting means.
6. Uniform transmittal of rotation, since there is no slip between gear teeth. Gearing is, therefore, an excellent means for transmitting synchronized motion.

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Figures 1, 2, and 3 illustrate typical construction of enclosed gear reduction drives:

Figure 1 illustrates a typical standard double reduction gearmotor construction of the horizontal type.

Figure 2 illustrates a vertical double reduction gearmotor construction.

Figure 3 illustrates a double reduction horizontal type speed reducer.

Since the concept of the American Gear Manufacturers' Association, it has been their aim to correlate application data used by various gear manufacturers into a standardized industry practice.

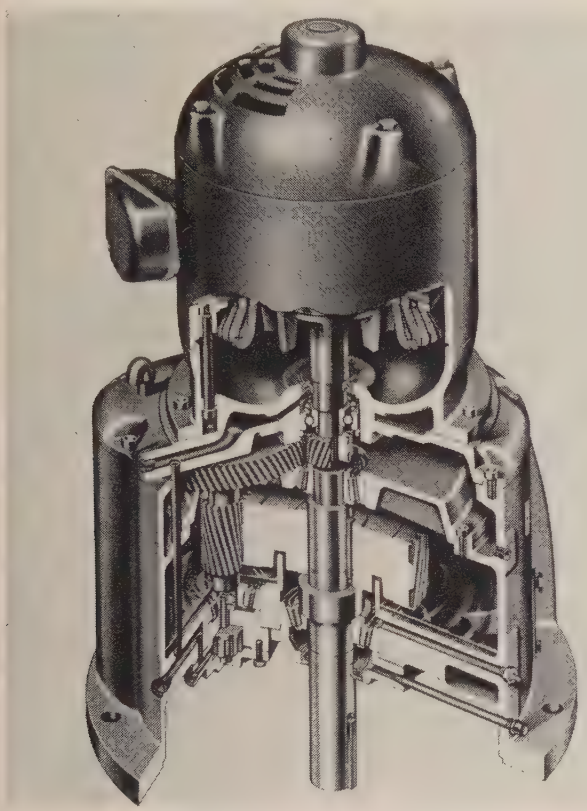


Fig. 2. Vertical double reduction gearmotor

The A.G.M.A. is constantly being on the alert to modify requirements for the industry based on experience and factual data, and their contribution to the industry has resulted in today's trouble-free paper machine gear drives. The present published service application factors for the pulp and paper industry are shown in Table I.

For gearmotors, there are three A.G.M.A. classifications but for the pulp and paper industry, it will be noted from the table that classes II and III only apply due to operating conditions encountered where 24 hours per day are usually required and the service being medium to heavy. However, the three A.G.M.A. classes are defined as follows:

Class I—For steady loads not exceeding the nominal rating of motor and 8 hours' a day service. Moderate shock loads where service is intermittent.

Class II—Applies to steady loads not exceeding nominal rating of the motor and 24 hours' a day. Moderate shock loads for 8 hours' a day.

Class III—Applies to moderate shock loads for 24 hours' a day or heavy shock loads for 8 hours' a day.

Table I

Typical applications, gearmotors			*Typical applications,[a] gear reducers (electric motor drives)*		
Application	*24 Hr. per day*	*Service class*	*Application*	*24 Hr. per day*	*Service factor*
Agitators-mixers		II	Barking drum		1.5
Bleachers		II	Calenders		1.5
Beater & pulper		III	Cylinders		1.5
Calenders		III	Drier section		1.5
Conveyors		II	Felt stretchers		1.5
Couch		III	Pulp grinders		1.5
Cylinders		II	Presses		1.25
Dryers		III	Pulp beaters		1.5
Felt stretchers		II	Suction rolls		1.25
Jordans		III	Chipper		1.75
Presses		III	Winders		1.25
Stock chests		III			
Suction rolls		III			
Winders		II			

[a] Starting loads usually determine the selection.

Basically, these three classifications are determined by the frequency of peak loading and its duration and pictorially illustrated by the curves shown in Fig. 4.

The applications, shown in Table I, are considered to be typical pulp and paper mill applications only and do not, by any means, cover all of the possible gear requirements in this industry. Knowing the application requirements, the curves in Fig. 4 can be dependably employed for gearmotor selection.

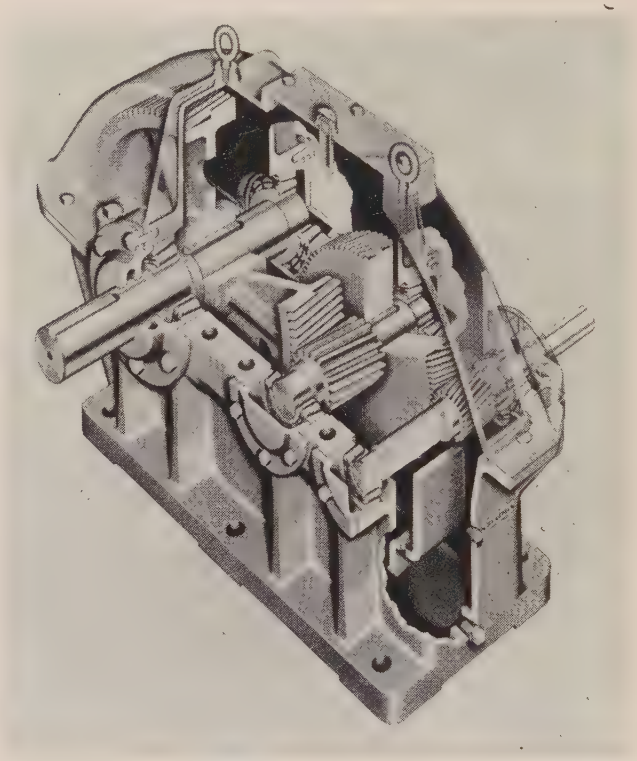


Fig. 3. Double reduction horizontal type speed reducer

Gearmotors, being essentially slow speed motors (gearmotor synchronous output speed for a.c. motors $= \frac{120 \times \text{no. of cycles}}{\text{no. poles} \times \text{gear ratio}}$ are "naturals" in the ma-

jority of applications within the rating range of the gearmotor.)

Gearmotors, in general, are designed to use N.E.M.A. standard motor frame sizes up to 75 hp. The gearmotor output or delivered slow speed r.p.m. has also been standardized by A.G.M.A. The standard output speeds are shown in Table II.

Table II. A.G.M.A. Standard Gearmotor Output Speeds (Based on 1750 r.p.m. Motors)

1430	68
1170	56
950	45
780	37
640	30
520	25
420	20
350	16.5
280	13.5
230	11.0
190	9.0
155	7.5
125	6.0
100	5.0
84	4.0

Since gear reducers are not necessarily driven by electric motors, the gear ratio rather than the output

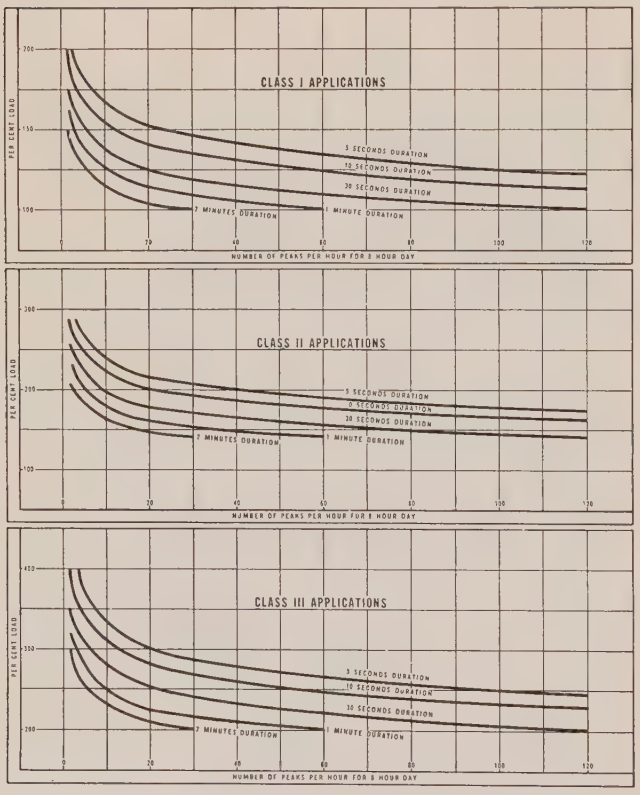


Fig. 4. Allowable peak loadings for gearmotor applications for peaks of indicated durations

revolutions per minute is in process of being standardized and the tentative speed reducer ratios are shown in Table III.

The output speed for gear reducers based on these ratios and 1750 r.p.m. motor speed will equal the gearmotor output speed shown in Table II. Normal tolerance on the output speed is considered to be ±2% for single gear reduction and ±4% for double, triple, and quadruple gear reductions.

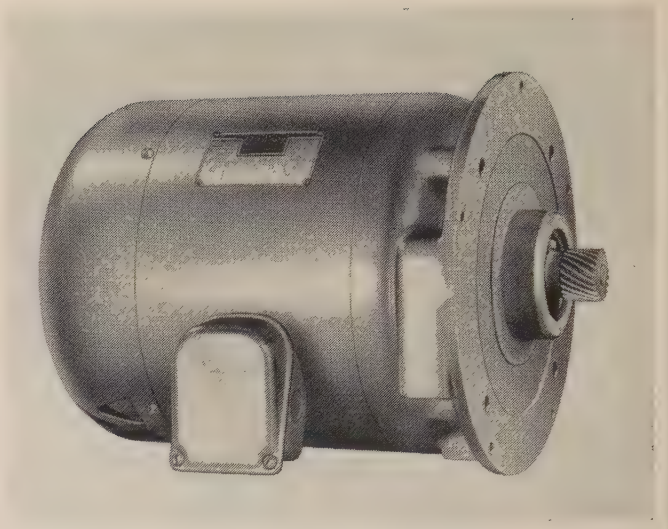


Fig. 5. Electric motor including rear end bracket and pinion

Where space is limited and at a premium, gearmotors are usually a popular and correct choice since they are the most compact type of power-transmitting equipment. A gearmotor of the construction shown in Fig. 1 is also very readily serviced.

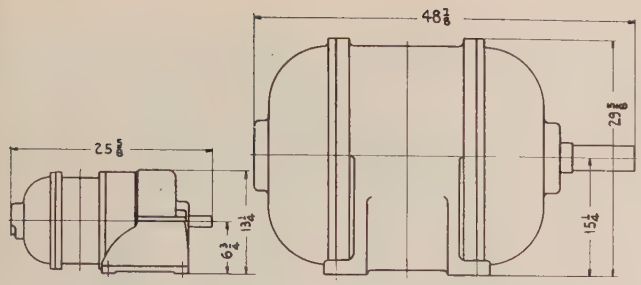
The electric motor, including the rear end bracket and pinion as shown in Fig. 5 may be detached from the gear unit without disturbing or removing the gear unit from its foundation or disturbing connected equipment

Table III. Tentative Standard Speed Reducer Ratios

1.225	47.08
1.500	57.67
1.837	70.63
2.250	86.50
2.756	105.9
3.375	129.7
4.134	158.9
5.062	194.6
6.200	238.4
7.594	291.9
9.300	357.5
11.39	437.9
13.95	536.3
17.09	656.8
20.93	804.5
25.63	985.3
31.39	1207.0
38.44	1478.0
....	1810.0

and the gearing is readily accessible for inspection or repair due to the horizontally split construction of the gear case. Since a gear reduction drive, be it a gearmotor or conventional coupled type speed reducer, transmits the motor horsepower at reduced speed, the output torque at the low speed shaft of a gear reducer becomes the motor torque multiplied by the gear ratio. The gear reducer housing must, therefore, be designed to transmit this higher torque and it is evident that the gearing parts and bearings must also be designed on this basis.

Figure 6 shows a typical comparison of output torque and the importance of gearing as a torque amplifier. The gearmotor shown in Fig. 6 is rated 5 hp. at 175 r.p.m. and utilizes a four pole, 60 cycle, 254 standard N.E.M.A. frame motor with a gear ratio of 10:1. A slow speed a.c. motor, to produce the equivalent r.p.m.,



Weight, 285 pounds Weight, 1910 pounds

Fig. 6

would have 40 poles. It is obvious that the gearmotor would occupy much less space, weigh much less and is also much more efficient.

What does this torque amplification mean to the user of gearing? Referring to Fig. 6, it is evident that if visualization of torque is made, neglecting the fact that the gear drive is small in physical size, the same provision for an adequate foundation should be made for the gearmotor as would be considered appropriate for the large motor in order to avoid premature difficulties and high maintenance cost.

Not only is it necessary to provide adequate support for the output torque when the gear drive is directly coupled to the driven apparatus, but also to take care of the overhung loads where the connection to the driven machinery is through a belt drive, chain, or open gearing.

Aside from gearmotors, when and where are other types of enclosed gear drives used?

As indicated above, standard gearmotors as a rule seldom exceed 75 hp. It is, therefore, logical to assume that coupled-type speed reducers should be applied above 75 hp. This is generally a good rule to apply but there are many circumstances affecting the selection of gear drives. Space limitation may dictate at times that gearmotors should be used in excess of 75 hp. (gearmotors have been built and applied to transmit horsepowers in excess of 300); at other times, the size and shape of the available space may be such that an individual gear drive may be more suitable. It may, therefore, be said that the individual requirement should dictate the type of drive selected as well as the economical considerations. Modern gear reducers and gearmotors are, in reality, precision type equipment. The gear and pinion shafts are generally supported by antifriction bearings of one of several conventional types. The use of bearings of the antifriction type assures alignment of unit shafts being maintained and, also, assures low friction losses particularly at the lower speeds. The gearing in enclosed gear drives is generally produced to high degrees of accuracies and the material used is of high-grade steel heat treated to give maximum life and maintenance of accuracy in tooth profile and spacing. As will be noted in Figs. 1, 2, and 3, the gearing shown is of the single helical type. This type of gear lends itself exceptionally well in manufacture to all of the modern improved gear cutting and finishing machines. This type of gear can be hobbed, formed by the shaper process then shaved or ground if such finishing methods are required. The hobbing process is generally considered as one of the most accurate methods of producing involute gear teeth and used extensively to produce gearing for industrial gear drives.

Table IV

A.G.M.A. lubricant No.	*Viscosity range S.U.V. seconds* *At 100°F.*	*At 210°F.*
1	180 to 240	.....
2	280 to 360	.....
3	490 to 700	.....
4	700 to 1000	.....
5	.....	80 to 105
6	.....	105 to 125

The gear teeth of single helical gears produced by either hobbing or the shaper process can be further refined by the shaving process. To utilize and derive the utmost in accuracy by shaving the gear teeth, they must first be accurately cut as the shaving process essentially is a means of making a good gear better. It may be in order to state that gear shaving is a finishing operation whereby very small amounts of metal are removed from the working surfaces of the gear teeth in order to correct minute errors in index, helical angle, tooth profile, and eccentricity. The result of such final finishing is a gear with a smooth tooth surface, assuring quiet operation and long life.

The lubrication of enclosed gear drives is generally accomplished by a simple and efficient splash system where the same lubricant is used for both gears and bearings. Ordinarily, in gear drives, straight mineral oil is a satisfactory lubricant.

Extensive investigations of suitable lubricants have been conducted by the gear manufacturers and refiners both independently as well as cooperatively. This investigation has resulted in a lubrication recommendation issued by the A.G.M.A. The viscosity range of the lubricant for typical operating conditions applicable to the pulp and paper industry is shown in Table IV.

Since the viscosity of mineral oil varies with temperatures, typical recommendations are shown in Table V for the various types of gear drives giving consideration to the ambient temperatures encountered.

Since the viscosity of the lubricant cannot be considered as a criterion of quality or load carrying capacity, the recommended viscosity range is supplemented by a list of refiners' tradenames covering lubricants of the straight mineral oil type that have been found to give generally satisfactory results under normal operating conditions. Where, for example, the loads are heavy or a combination of heavy load and shock conditions exist, it has been found that a noncorrosive mild

Table V

Type of units	*Size of units*	*Ambient temperature, °F. 0–40 use A.G.M.A. No.*	*41–100 use A.G.M.A. No.*	*101–150 use A.G.M.A. No.*
Parallel shaft units	Low-speed, centers up to 20 in.	2	4	5
	Low-speed, centers over 20 in.	3	5	6
Planetary gear units	O.D. of housing up to 16 in.	2	3	4
	O.D. of housing over 16 in.	3	4	5
Gearmotors	All sizes	2	4	5
Spiral or straight bevel gear units	Cone distance up to 12 in.	2	4	5
	Cone distance over 12 in.	3	5	6
High-speed units	All sizes	1	2	3

extreme pressure lubricant (generally referred to as an EP oil) may be highly beneficial and instrumental in preventing scoring, scuffing, and galling of gear teeth as well as, to some extent, be helpful in preventing so-called insipient or corrective pitting. So-called EP lubricants have also been found desirable to use where, for example, the operating temperature of mineral oil lubricant appeared high due probably to some change to operating conditions, such as increased speed, as it, in many cases, becomes possible to change to a lighter grade of the EP type lubricant and, thus, reduces the operating temperatures.

Up to now, we have considered the more obvious types of gearing in the pulp and paper industry. However, before leaving the subject of gearing, the author would like to introduce one application where high-speed gearing is used as a means of transmitting the motion and torque from an electric motor to a high-speed compressor used in air-conditioning service.

Air conditioning has witnessed tremendous popularity within the last decade and found its way into office buildings in industrial plants as well as in the industrial plants proper.

A typical air-conditioning installation is shown in Fig. 7 and illustrates the application of a high-speed gear drive that may find its way into and be a useful tool in the pulp and paper industry. The construction of gear drives for this application and applications in general where high speed is required either as a step-up of the prime mover speed or step down is illustrated in Fig. 8. This type of gear drive is generally used in applications where the speed is in excess of 3600 r.p.m. or the pitchline velocity is exceeding 4000 f.p.m. The gears are of the double helical type. The groove in the center of the gear is introduced to avoid trapping of the lubricant and provides smoother running. High-speed gears must be accurately produced and dynamically balanced. The gear and pinion shafts are oversize in order to provide added stiffness and provide protection against bending and torsional deflections under power torque variations.

The bearings are generally of the sleeve type designed to operate under low-unit pressures. Gears and bearings are forced feed lubricated. High-speed units of this type are generally considered standard up to 9000

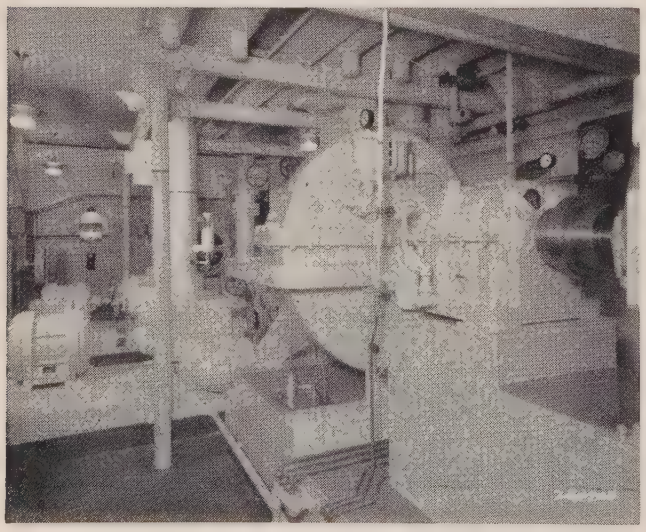


Fig. 7. Typical air-conditioning system

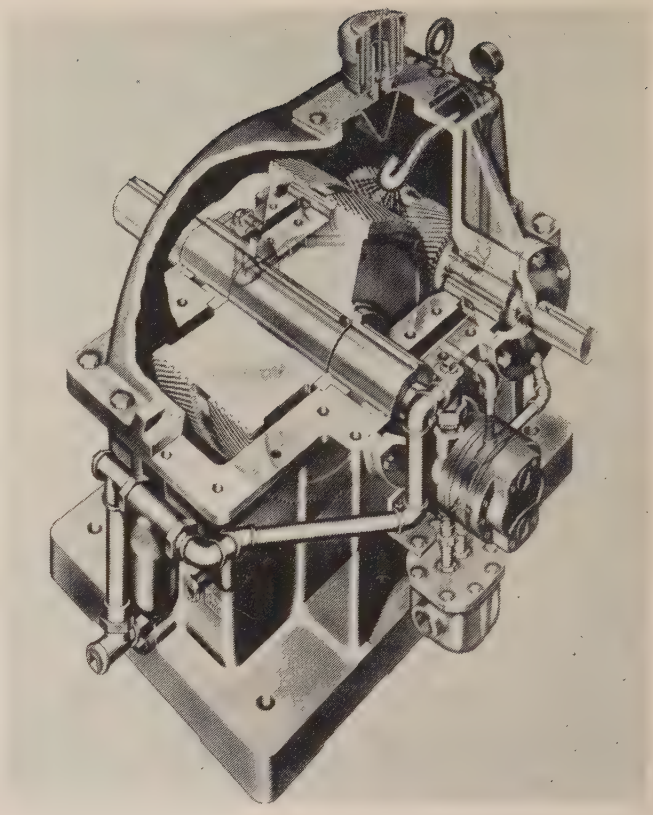


Fig. 8. High-speed gear drive

r.p.m. and 10,000 f.p.m. pitchline velocity. On special gear increasers, the speed may be in excess of 30,000 r.p.m. at pitchline velocities of 20,000 f.p.m. and up.

In closing, the author would like to briefly review the gearing industry's past, present, and future.

Historical data on gearing and available literature indicate that "toothed wheels" or gears were in use as early as 330 B.C. and were one of the earliest forms of continuous mechanical power transmission. This might indicate that the gearing industry has had plenty of time to perfect the art of making gears and be satisfied to lay down on its laurels. This, however, is not the case as in the last quarter century; the gearing industry has made more progress than in all its previous history and new developments are constantly in process.

Some of the latest improvements in the production of gearing refer to the greater degree of accuracy obtainable. Today, it is not unusual to hob gear teeth to an accuracy in tooth spacing of less than 0.00025 inch. Grinding equipment for grinding gear teeth is now available that will hold the spacing from tooth to tooth to less than 0.00015 inch.

Gear teeth shaving equipment which will produce minute corrections in tooth spacing, curvature, lead, and finish is instrumental in producing quieter and still more acceptable gearing.

Research on gear material and heat treatment is another activity being pursued constantly and has resulted in substantial increases in load carrying capacity and durability of gearing. It is the aim of the gear manufacturer to advance the art of making gears and keep abreast of developments in your industry so that the gearing you require will be available to meet your future requirements.

Presented at the Fifth Engineering Conference sponsored by the Technical Association of the Pulp and Paper Industry, Cincinnati, Ohio, Oct. 2–5, 1950.

Beating, Tensile Strength, Specific Surface, and Optically Bonded Area of Pulp

MORRIS W. KANE

Recently a theory was presented on the development of tensile strength during the beating of pulp. This theory was based on a small amount of experimental data and a considerable number of assumptions. In applying this theory to the data, it was possible to arbitrarily choose five unknowns in an equation containing six. This raises the objection that the equation can be fitted to any curve similar to a tensile versus beating time curve. Since presenting the theory, an article by Ratliff has afforded a means of estimating, from experimental data, more of the above-mentioned unknowns. When the theory was applied to these data, no inconsistencies were observed.

A THEORETICAL equation giving tensile strength of a pulp as a function of beating time and of constants peculiar to the beating equipment and pulp has been presented recently (*1*). This equation is:

$$T = T_0 + \left[\frac{B}{B+K}\right]\left[1 - \left(\frac{1}{1+K\theta}\right)^{1+B/K}\right]\left[T_m - T_0\right] \quad (1)$$

where

T = the tensile strength at time θ
T_m = the maximum tensile strength obtainable under the most ideal beating conditions
T_0 = the tensile strength of the unbeaten pulp
K = a constant = the cutting rate for the particular beating equipment and pulp used
B = a constant = the hydrating rate for the particular beating equipment and pulp used
θ = the beating time

The use of this equation was simplified by giving θ a value equal to the actual time in the beater plus a constant. This constant was so chosen that when the tensile versus beating time curve was extrapolated to tensile equals zero, θ equaled zero. The equation then became:

$$T = \left\{\frac{B}{B+K}\right\}\left\{1 - \left[\frac{1}{1+K(h+h_0)}\right]^{1+B/K}\right\}T_m \quad (2)$$

where

h = actual time in the beater (corrected if necessary)
$h_0 = \theta - h$ = a constant

In applying this equation to experimental data, it was possible to select arbitrary values of B, K, h_0, and T_m; an arbitrary value of zero having already been assigned to T_0. Consequently the equation could be made to fit any curve of the tensile versus beating time form. If more of the unknowns could be obtained from experimental data, a better check on the validity of the equation would be obtained.

Work by Ratliff (*2*) affords a means of estimating the values of K and T_m from experimental data. The following analysis will attempt to show that no apparent inconsistencies arise when the equation is applied to Ratliff's data.

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ANALYSIS OF DATA

1. In using Ratliff's data, it was arbitrarily assumed that, due to sampling, the beating rate increased after each beating interval as follows:

After first interval, beating rate equals 10/9 of original rate.
After second interval, beating rate equals 10/8 of original rate.
After third interval, beating rate equals 10/7 of original rate.
After fourth interval, beating rate equals 10/6 of original rate.

This correction was applied by increasing the length of the beating intervals as shown in Table I.

2. It was next assumed that tensile strength is a function of the fraction of the specific surface which is optically bonded. Consequently the ratio of optically bonded area to specific surface was plotted against tensile strength. This curve was extrapolated to the point where the optically bonded area and the specific surface were equal (see Figs. 1, 2, 3, 4, and 5). The tensile strength at this point was called T_m, the maximum tensile strength obtainable under the most ideal beating conditions.

3. The ratio of experimental tensile strength to maximum tensile strength (T/T_m) was then determined at each beating interval and this ratio plotted against

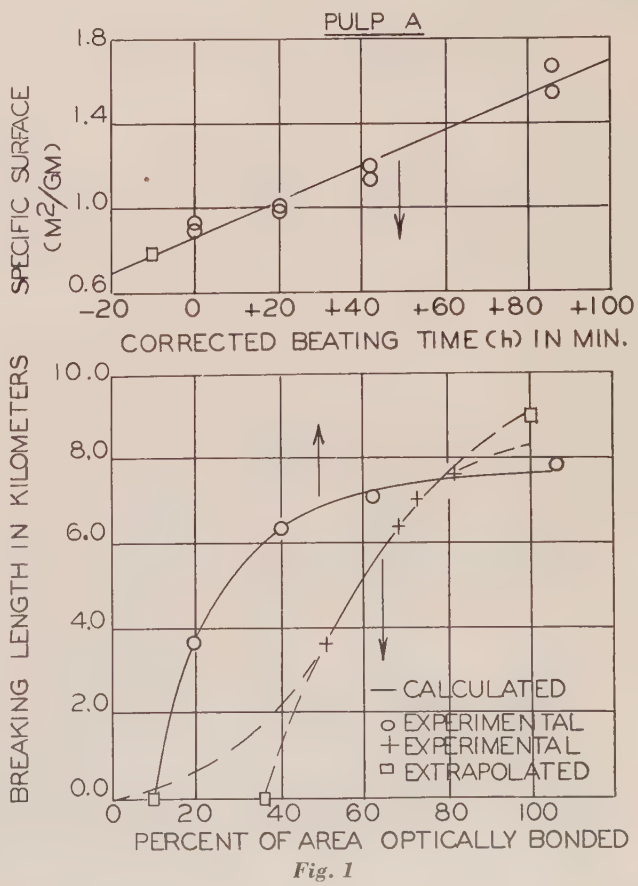

Fig. 1

Table I

Breaking Time in Minutes									
Pulp A		Pulp B		Pulp C		Pulp D		Pulp E	
Actual	Corrected	Actual	Corrected	Actual	Corrected	Actual	Corrected	Actual	Corrected
0	0	0	0	0	0	0	0	0	0
20	20	20	20	20	20	20	20	20	20
40	42	40	42	40	42	40	42	40	42
75	86	80	92	75	86	80	92	75	86
..	..	..	..	95	115	..	..	95	115

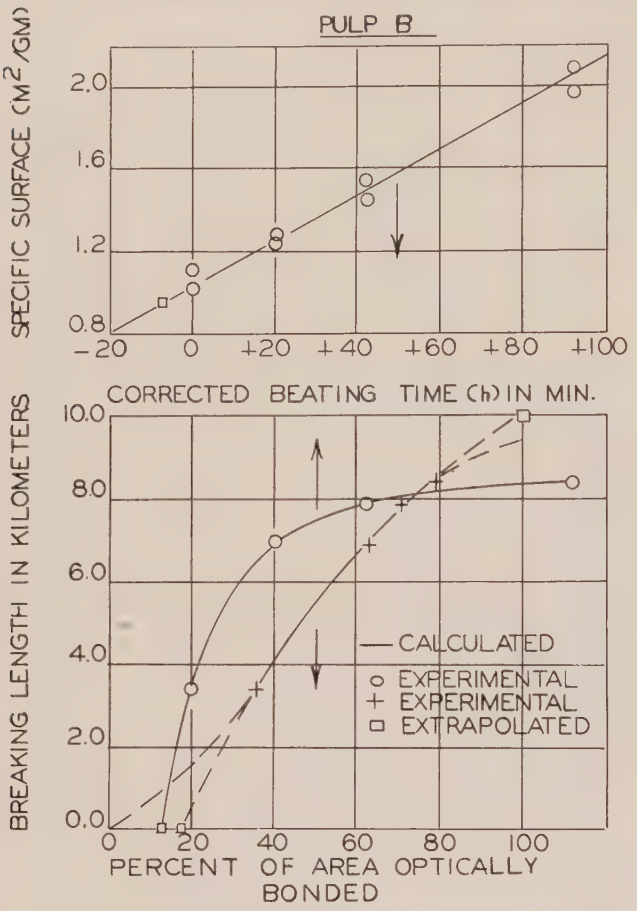

Fig. 2

the corrected beating time (h) (see Figs. 6a, 6b, and 6c).

4. A series of theoretical curves were now prepared by plotting T/T_m against θ as calculated by substituting various values of B, K, and θ in equation (3) (see Figs. 6a, 6b, and 6c). Equation (3) is a modification of equation (2).

$$T/T_m = \left[\frac{B}{B+K}\right]\left[1 - \left(\frac{1}{1+K\theta}\right)^{1+B/K}\right] \qquad (3)$$

5. The curve obtained in step (3) above was superimposed on the curves prepared in step (4) until a curve was found with which it coincided (see Figs. 6a, 6b, and 6c). Following this procedure, it was possible to estimate the time when tensile strength was zero and consequently the value of the constant h_0. At the same time the values of B and K were obtained.

6. By adding the constant h_0 to the corrected beating time (h), the so-called true beating time (θ) was obtained. The values of K, B, and θ were then substituted in equation (3) and the calculated values of tensile strength compared with the experimental values. These comparisons are shown in Figs. 1, 2, 3, 4, and 5 as well as in Table II.

7. Finally Ratliff's value of the specific surface as obtained by the silvering technique was plotted against the true beating time θ. The slope of the least squares line through the points, divided by the specific surface at θ equals zero should have the same value as K obtained in step (5) above. Table III shows that this is apparently true.

DISCUSSION

When the fraction of surface optically bonded was

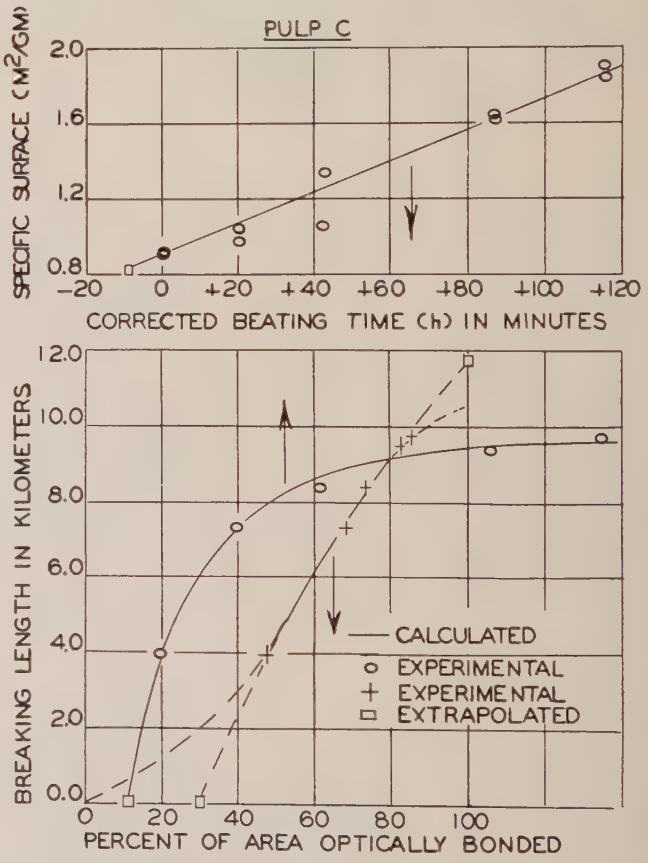

Fig. 3

Table II. Breaking Length in Kilometers

Actual minutes in beater	Pulp A		Pulp B		Pulp C		Pulp D		Pulp E	
	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental	Calculated	Experimental
0	3.61	3.62	3.26	3.40	3.65	3.95	3.45	3.41	4.56	4.30
20	6.41	6.40	6.91	6.90	7.31	7.35	7.66	7.86	8.50	8.50
40	7.24	7.10	7.87	7.90	8.75	8.37	9.00	8.97	9.91	9.75
75	7.56	7.70	...	...	9.52	9.40	...	...	10.60	10.50
80	...	...	8.40	8.40	...	...	9.62	9.65	...	...
95	...	...	...	...	9.63	9.72	...	...	10.70	10.85

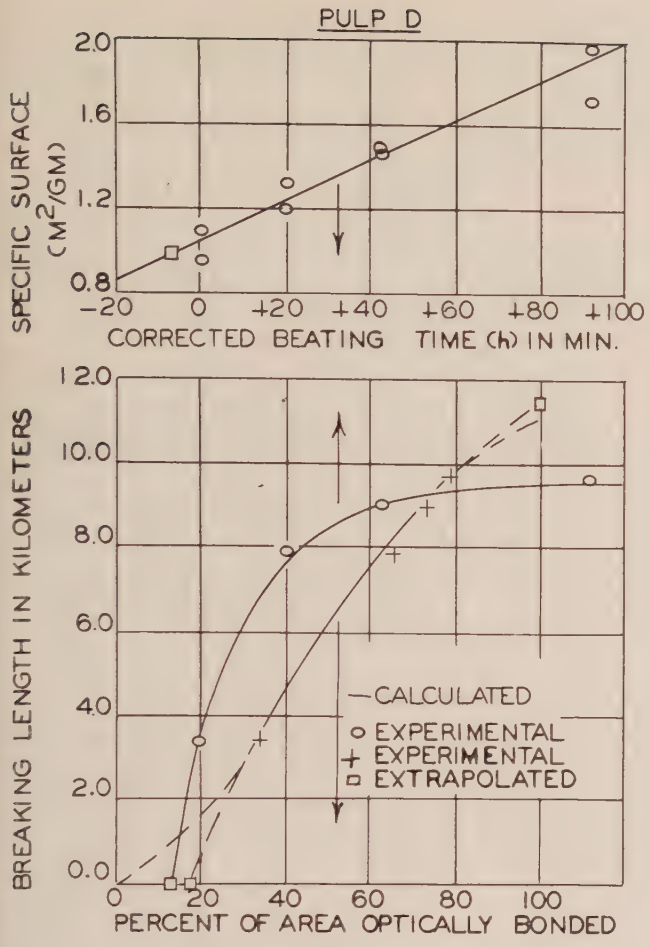

Fig. 4

plotted against the tensile strength and the curve extrapolated, it was noted that there seemed to be a large amount of optically bonded surface when the tensile strength was zero. If the extrapolation is justified, this may mean that unhydrated surfaces in contact affect the optically bonded surface determination but have no bonding properties that affect the tensile strength. If this is not true, there is an objection to determining the maximum tensile by extrapolating to the point where all of the area is optically bonded.

In the theory on tensile development during beating, three possible equations were suggested. There are many other possible equations in this range. The three suggested equations, which were not given, reduce to the following:

Table III

Pulp	*A*	*B*	*C*	*D*	*E*
K from silvering technique	0.0107	0.0115	0.0099	0.0095	0.0072
K used in equation	0.011	0.011	0.0090	0.0095	0.0070
B used in equation	0.059	0.060	0.045	0.055	0.050
T_m from optical measurements	9.1	10.0	11.7	11.4	12.3
T_m used in equation	9.1	10.0	11.7	11.4	12.3
T_0 arbitarily chosen	0.0	0.0	0.0	0.0	0.0
h_0 used in equation	10.0	7.0	9.0	7.0	10.0

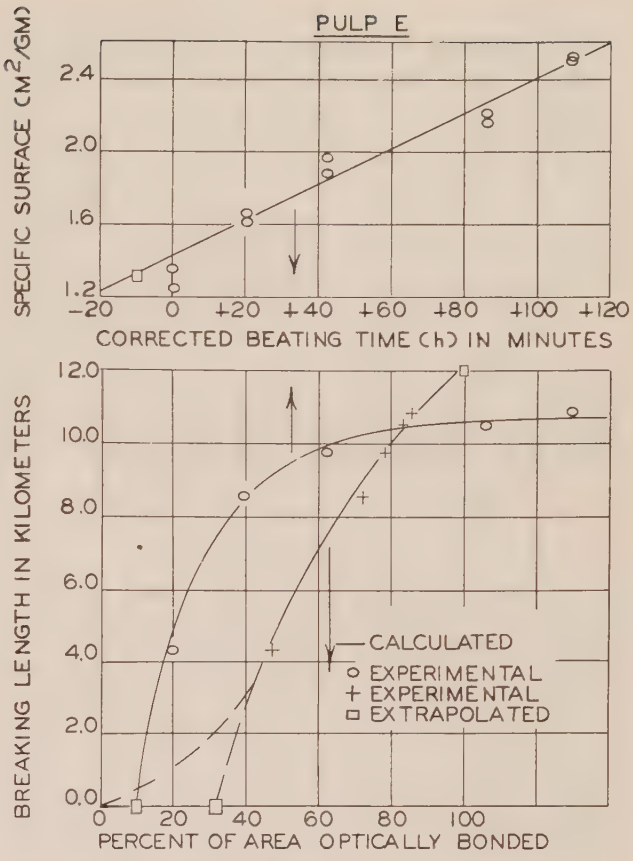

Fig. 5

$$T = T_0 + \{T_m - T_0\} \left\{\frac{B}{B+K}\right\} \left\{1 - \left(\frac{1}{1+K\theta}\right)^{1+B/K}\right\} \quad (4)$$

or if $T_0 = 0$

$$T \propto A/S$$

$$T = T_m - [T_m - T_0] \left[\frac{K + B\left(\frac{1}{1+K\theta}\right)^{1+B/K}}{B+K}\right]^2 \quad (5)$$

or if $T_0 = 0$

$$T \propto 2A(S-A)/S^2$$

$$T = T_0 + \{T_m - T_0\} \left\{\frac{B}{B+K}\left[1 - \left(\frac{1}{1+K\theta}\right)^{1+B/K}\right]\right\}^2 \quad (6)$$

or if $T_0 = 0$

$$T \propto (A/S)^2$$

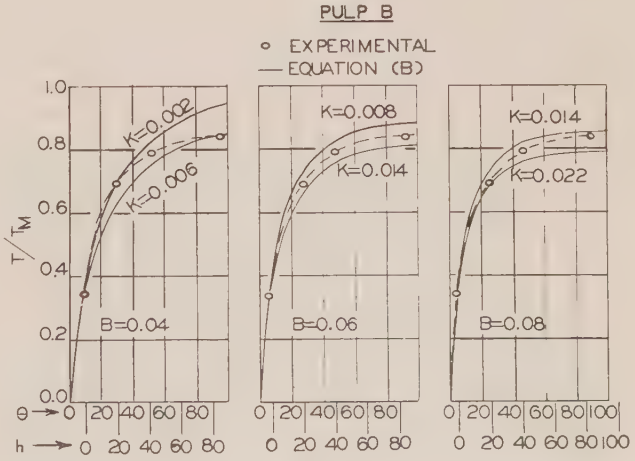

Fig. 6

By a study of the relation between optically bonded area and tensile, some light might be thrown on which of these three equations or what other equation is the most satisfactory.

The question of the amount of surface not in contact due to fiber length, poor compacting, and so forth might be studied by using the method described by Brown (*3*). The necessary correction might be applied as mentioned in the theory on tensile and beating (*1*) under comment number 8.

Another check on the validity of the equation might be made by beating pulp in a beater having a high value of B and a low value of K. After the pulp has been well beaten, it could be transferred to a beater having a low value of B and a high value of K to determine if a decrease in tensile strength is obtained.

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Resin Bonding of Offset Papers Containing Mineral Fillers

MARTIN J. O'LEARY, BOURDON W. SCRIBNER, and JOSHUA K. MISSIMER

Papermaking studies at the National Bureau of Standards have shown that melamine-formaldehyde resin, used as a binding agent in offset lithographic papers containing no mineral fillers, has the beneficial effects of improved printing quality, decrease in the beating time of the fibers, and large increase in permissible content of hardwood fibers. The last is desirable for the conservation of the scarcer softwood fibers. The previous work has shown that as little as 1 1/2 hours of beating give satisfactory results with the usual 50% hardwood fibers increased to 75%, when 1 to 3% melamine resin is added. Further investigation has been made to determine whether these beneficial effects occur when the mineral fillers, clay and titanium dioxide, are used. With 1 1/2 hours of beating of a fiber furnish consisting of 75% soda pulp (hardwood fibers) and 25% sulphite pulp (softwood fibers) 15% clay made the papers too soft for lithographic papers, lowering all of their desirable physical properties. The addition of the melamine resin had little or no beneficial effect on these papers. However, with a 50% sulphite, 50% soda, 15% clay furnish, the physical properties were improved by the addition of 3% melamine resin, resulting in good lithographic papers. The clay retention was lowered slightly by the addition of 3% melamine resin, and more so with 1% melamine resin. When the stock was given 5 1/2 hours of beating, the melamine resin was of assistance in producing improved lithographic papers made from 75% soda pulp and 25% sulphite pulp. When 3% titanium dioxide was added to both 50% soda, 50% sulphite, and 75% soda, 25% sulphite furnishes with 5 1/2 hours of beating and 1 and 3% of melamine resin added, satisfactory offset papers were produced. The retention of the titanium dioxide was decreased somewhat by the resin. As reported in an earlier publication, the retention of both fillers was improved by using an excess of aluminum sulphate and adjusting the stock to the desired pH with sodium carbonate.

Previous investigations in the paper mill of the National Bureau of Standards on the use of melamine-formaldehyde resin as a binding agent in offset papers, have shown that the resin imparted better printing quality, decreased the beating time required for the fibers, and permitted the use of a greatly increased proportion of hardwood fibers in the papers. As little as 1 1/2 hours of beating gave satisfactory results with the usual 50% of the short, weak hardwood fibers increased to 75% (*1*, *2*). The use of the larger content of hardwood fibers is desirable for the conservation of the scarcer softwood fibers.

In the previous work, no mineral filler was used. This is a desirable component because it fills the interstices between the fibers of paper and imparts a better finish and higher opacity, all of which are favorable for improved printing quality. This article gives the results of an investigation of the influence of mineral fillers on the beneficial effects of the binding resin, and the effect of the resin on the retention of the fillers in the paper.

EXPERIMENTAL PAPERMAKING EQUIPMENT

The papermaking equipment at the Bureau is semi-commercial in size and is adapted to the experimental manufacture of papers under conditions that simulate those of typical industrial plants. Detailed description and photographs of the essential equipment are contained in previous publications (*3*, *4*).

The equipment used in this work consisted essentially of a 50-pound beater with a copper-lined wooden tub and manganese-bronze bars and plate; a jordan refiner with bars of bronze and steel alloy; a four-plate, flat screen and a 29-inch fourdrinier papermaking machine with a wire 33 feet in length; two presses; nine 15-inch driers; a machine calender stack of seven rolls; a reel; a supercalender with five rolls; three steel rolls; two cotton rolls; and a 38-inch trimmer.

PAPERMAKING RAW MATERIALS

Different percentages of the following commercial pulps were used in this study: (1) bleached sulphite, made by cooking eastern spruce wood, a softwood, in a solution of calcium bisulphite. This is a relatively standard quality of pulp such as is commonly used for offset paper; (2) bleached soda, a filler pulp produced by cooking poplar wood, a hardwood, in a strong solution of caustic soda. This is an unusually strong soda pulp for a short fibered stock.

The chemical characteristics of the pulps used are shown in Table I.

The fillers were 15% clay and 3% titanium dioxide. Their chemical compositions are given in Table II. The fillers were mixed with water and screened through an 80-mesh wire to remove dirt or foreign ingredients.

Martin J. O'Leary, Bourdon W. Scribner, and Joshua K. Missimer, National Bureau of Standards, U. S. Department of Commerce, Washington, D. C.

Table I. Test Data on Pulp Used in Experimental Papers

Kind of pulp	Alpha-cellulose,[a] %	Beta-cellulose,[a] %	Gamma-cellulose,[a] %	Pentosans, %	Copper number, %	Ash,[b] %	Natural resin,[b] %	Acidity (glass electrode), hot water extraction, pH
Sulphite	85.2	3.5	11.3	3.5	1.4	0.20	0.42	6.6
Soda	79.7	17.7	2.6	15.3	1.5	1.80	0.38	8.4

[a] Based on total cellulose.
[b] Oven-dry basis.

The retention of the fillers in the paper was determined by the formula

$$\text{Retention} = \frac{0.94B(100 - C - A)}{A(100 - C - B)}$$

in which

A = per cent of ash in oven-dry stock going to machine
B = per cent of ash in oven-dry paper at reel
C = per cent of oven-dry filler lost on ignition

One per cent rosin size precipitated with aluminum sulphate was used on all the runs.

Melamine-formaldehyde resin 607 of the American Cyanamid Co. was used as the binding agent.

All percentages of materials added to the pulp are based on the oven-dry (110°C.) weight of the pulp.

MANUFACTURING PROCEDURE

Fifty pounds of fibers were furnished to the beater in each instance. When clay was added, the fibers were 85%, and the clay was 15% of the furnish, making a total of 58.8 pounds in the beater.

When titanium dioxide was used, 97% of the furnish was fibers and 3% titanium dioxide, making a total of 51.55 pounds.

An excess of alum was used when a filler was furnished to the beater, because it was found in the study of experimental manufacture of paper for war maps (*5*) that by adding an excess of alum and then adjusting the pH with sodium carbonate, the retention of the pigment was increased, resulting in a decided improvement in the opacity of the paper. A minimum and a medium beating time were used. A detailed description of the roll setting may be found in a previous publication on offset papers (*6*).

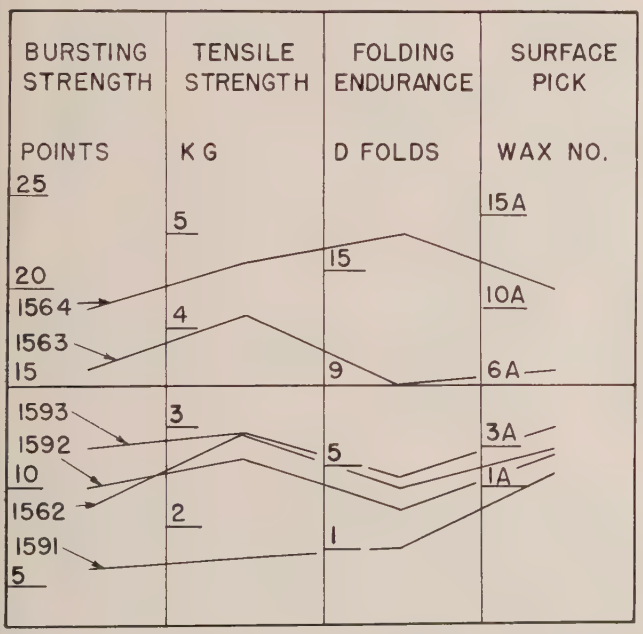

Fig. 1. Effects of melamine resin on physical properties of papers containing clay filler. Pulp: 75% soda, 25% sulphite. Beating time: 1 1/2 hours

1562, no M, no clay
1563, 1% M, no clay
1564, 3% M, no clay
1591, no M, 15% clay
1592, 1% M, 15% clay
1593, 3% M, 15% clay

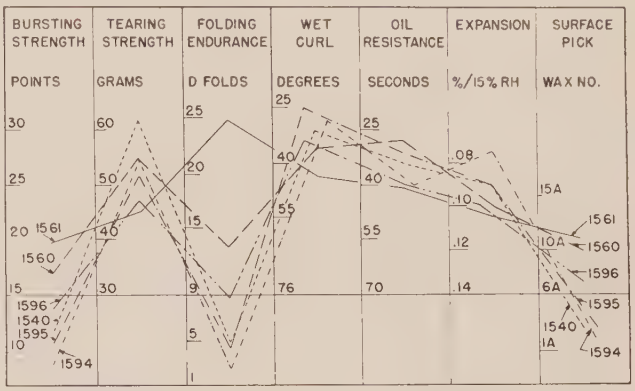

Fig. 2. Effects of melamine resin on physical properties of papers containing clay filler. Pulp: 50% soda, 50% sulphite. Beating time: 1 1/2 hours

1540, no M, no clay
1560, 1% M, no clay
1561, 3% M, no clay
1594, no M, 15% clay
1595, 1% M, 15% clay
1596, 3% M, 15% clay

With the minimum beating time, 1 1/2 hours, the stock received only a mixing just long enough to thoroughly separate the fibers and give fillers, size, and alum a good mixing. Such treatment does not develop strength in the paper.

With the medium beating time, 5 1/2 hours, the stock received a light brushing for 1/2 hour. This treatment slightly frays out the fibers causing them to interlace better in forming a sheet of paper. It also makes the surface a little harder which helps to minimize fuzz.

A longer beating time creates a gelatinous substance on the fibers. It also makes a hard, brittle sheet of paper. The more gelatinous substance that is combined with the finished paper, the more the paper will expand when it becomes wet and contract when it dries. This expansion and contraction of the paper causes misregister in offset lithographic printing.

The beaten stock was dropped to the chest and pumped in a continuous stream through the stuff box into the jordan.

The stuff box is divided into three compartments: one section receives the stock from the pump; the second compartment has a gate that regulates the desired amount of stock delivered to the machine per hour; the third section receives the surplus stock, which then returns to the machine chest.

The jordan was used only for mixing the fibers with the same setting for all runs.

Table II. Composition of Fillers Used

Fillers	Loss at 105°C., %	Further loss on ignition, %	Silica (SiO_2), %	Iron oxide (Fe_2O_3), %	Alumina (Al_2O_3), %	Titanium dioxide (TiO_2), %
Clay	0.3	13.8	45.3	0.2	38.8	1.8
Titanium dioxide	None	0.15	None	None	None	98.2

Run no.	Beating time, hr.	Beater furnish: Pulp	Filler: Kind	Filler: Amount, %	Resin,[b] %	Retention of resin, %	Basis weight: (25 × 40—500), lb.	Thickness, in.	Bursting strength, pt.	Folding endurance (double folds), MIT (tension 1 kg.), direction: Machine	Folding endurance (double folds), MIT (tension 1 kg.), direction: Cross	Tensile strength, direction: Machine, kg.	Tensile strength, direction: Cross, kg.
1562	1 1/2	25% bleached sulphite,	None	..	..	..	53.2	0.0034	9	4	4	3.3	2.5
1563		75% bleached strong	..	..	1M	81	54.0	0.0033	16	10	8	4.8	3.5
1564		soda	..	..	3M	84	54.3	0.0033	19	18	16	5.4	4.0
1591			Clay[a]	15	..	..	52.4	0.0034	6	1	1	2.1	1.3
1592			Clay	15	1M	75	54.5	0.0031	10	4	2	3.3	2.1
1593			Clay	15	3M	70	54.2	0.0034	12	5	4	3.4	2.4
1540	1 1/2	50% bleached sulphite,	..	..	..	..	54.8	0.0040	12	6	4	3.7	2.6
1560		50% bleached strong	..	..	1M	93	54.4	0.0036	17	15	12	4.7	3.3
1561		soda	..	..	3M	70	53.6	0.0031	20	29	21	5.9	3.8
1594			Clay	15	..	..	54.6	0.0032	9	3	2	2.7	1.7
1595			Clay	15	1M	83	52.5	0.0031	11	6	3	3.3	2.0
1596			Clay	15	3M	74	54.6	0.0032	14	10	8	4.1	2.7
1621	5 1/2	50% bleached sulphite,	None	..	..	..	55.4	0.0039	16	12	8	4.9	2.9
1622		50% bleached strong	..	..	1M	81	54.3	0.0037	21	38	22	6.3	3.8
1623		soda	..	..	3M	77	52.8	0.0035	24	63	38	6.7	4.3
1616			Clay	15	..	..	54.8	0.0034	11	5	4	3.9	2.1
1617			Clay	15	1M	73	54.7	0.0036	14	9	5	4.1	2.4
1599			Clay	15	3M	73	53.8	0.0031	17	16	11	5.2	3.0
1605			TiO_2[d]	3	..	..	53.2	0.0034	16	12	6	5.1	2.7
1620			TiO_2	3	1M	75	54.9	0.0036	19	24	14	5.9	3.3
1607			TiO_2	3	3M	67	53.5	0.0035	22	34	21	6.3	3.9
1624	5 1/2	25% bleached sulphite,	None	..	..	..	54.1	0.0039	12	6	4	4.2	2.5
1625		75% bleached strong	..	..	1M	75	53.8	0.0038	19	15	10	4.9	3.4
1626		soda	..	..	3M	76	56.1	0.0039	22	27	21	5.9	4.3
1618			Clay	15	..	..	54.9	0.0036	10	3	2	3.3	1.9
1619			Clay	15	1M	86	54.9	0.0034	13	6	4	4.0	2.4
1598			Clay	15	3M	78	52.9	0.0030	15	8	6	4.5	2.7
1608			TiO_2	3	..	..	53.6	0.0038	14	7	4	4.2	2.7
1609			TiO_2	3	1M	75	53.9	0.0037	17	12	8	5.7	3.3
1610			TiO_2	3	3M	70	55.1	0.0037	19	16	10	5.8	3.5

[a] All physical tests made under condition of 50% relative humidity and 73°F., by the Standard Methods of the Technical Association of the Pulp and Paper Industry.
[b] M is an abbreviation of melamine resin.

From the jordan the stock drains into a fan pump and is mixed with the white water from the paper machine. The mixture is then pumped to a riffle box that contains several baffle boards. The stock flows over these baffle boards, and the heavy particles, such as sand, metal, etc., settle to the bottom of the box. From the riffle box the stock flows through a screen with slots cut 0.018 inch, thence to the headbox onto the wire.

Melamine-formaldehyde resin was added in the form of a colloidal solution made by dissolving the powdered resin in warm water acidified with hydrochloric acid.

The formula used in this study was submitted in 1943 by the American Cyanamid Co.

Thirty-nine pounds of 20° Bé. hydrochloric acid is added to 50 gallons of water and heated to 140°F.; 100 pounds of melamine resin 607 is added slowly to the acid solution while stirring; the resin solution is added to cold water to make a total volume of 100 gallons.

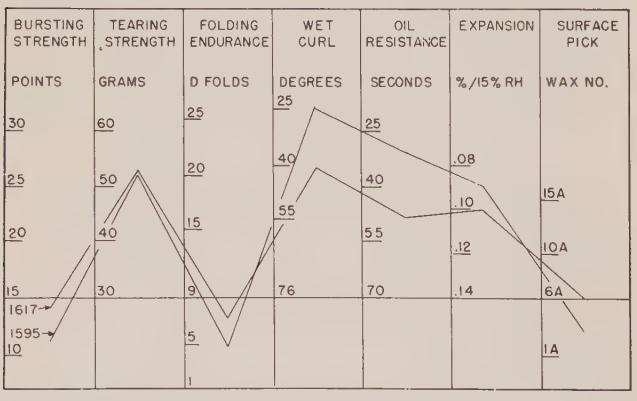

Fig. 3 Comparison of effects of beating times of 1 1/2 hours and 5 1/2 hours. 15% clay, 1% melamine resin. Pulp: 50% soda, 50% sulphite

1595, beating time, 1 1/2 hours
1617, beating time, 5 1/2 hours

The resin was added at the screen hopper, after the stock had left the screens and before the headbox. There are two reasons for adding the resin at this particular place; first, melamine resin has an affinity for dirt, therefore, it should be added at a point after the dirt has been removed; second, melamine resin should have the minimum amount of agitation to obtain maximum efficiency of wet strength in the paper, but should be added at a point where the resin will have time to obtain uniform distribution in the stock before it flows onto the wire. The temperature of the stock was maintained at 90 ± 2°F. One per cent of rosin size was used in each of the papers. It was precipitated with papermaker's alum, $Al_2(SO_4)_3$ which was used to control the pH of the stock.

The finish imparted by the small machine calenders was low, therefore a light supercalendering of the paper was necessary so that the finish would be comparable to that of commercial papers.

TESTING

All physical and chemical tests of the pulps and papers referred to herein were made in accordance with the standard methods of the Technical Association of the Pulp and Paper Industry (7).

The pH of mill waters at the beater, stuff box, and headbox was determined with a glass electrode.

INTEPRETATION AND DISCUSSION OF TEST DATA

The test data for the experimental papers are given in Table III and shown graphically in the figures.

aldehyde Resin on Offset Papers Containing Mineral Fillers[a]

Tearing resistance, direction Machine, g.	Tearing resistance, direction Cross, g.	Expansivity (15% change in relative humidity), direction Machine, %	Expansivity (15% change in relative humidity), direction Cross, %	Opacity (contrast ratio), %	Smoothness (Bekk), sec.	Pick (Dennison wax), no.	Oil penetration, sec.	Air permeability, sec.	Curl, deg.	Hot water extraction, acidity, pH	Ash in beater stock, %	Ash in paper, %	Retention of filler, %	Run no.
47	49	0.05	0.12	91	148	3A	36	32	32	5.0	..	..	..	1562
46	47	0.06	0.13	90	147	7A	36	38	33	5.1	..	..	..	1563
46	44	0.05	0.14	89	151	11A	38	46	36	5.1	..	..	..	1564
45	45	0.05	0.12	91	114	— 2A	27	21	22	4.9	14.0	11.4	74	1591
42	50	0.05	0.13	91	258	3A	36	48	30	4.6	13.9	10.7	69	1592
43	44	0.05	0.13	91	180	4A	33	43	30	4.7	13.6	11.1	72	1593
61	63	0.05	0.13	88	64	3A	34	22	31	4.5	..	..	..	1540
57	58	0.06	0.14	87	79	10A	28	29	36	5.2	..	..	..	1560
46	44	0.06	0.15	87	166	11A	41	48	43	4.8	..	..	..	1561
53	60	0.05	0.10	89	254	2A	40	42	28	5.2	13.6	11.0	74	1594
48	56	0.05	0.13	89	178	3A	31	38	25	4.8	13.9	10.0	64	1595
46	49	0.05	0.15	90	235	7A	40	60	34	4.7	13.4	10.6	72	1596
63	61	0.05	0.14	88	58	3A	44	35	36	4.2	..	..	..	1621
52	51	0.06	0.16	87	73	10A	38	41	44	4.6	..	..	..	1622
48	45	0.07	0.17	86	59	11A	43	43	43	4.5	..	..	..	1623
53	58	0.05	0.15	90	163	2A	49	65	41	4.3	14.0	12.2	78	1616
50	55	0.05	0.15	90	83	6A	48	54	41	4.4	14.6	11.7	72	1617
42	40	0.06	0.16	90	164	8A	65	82	46	4.7	15.7	12.3	70	1599
48	51	0.06	0.17	91	111	6A	50	58	56	4.6	4.2	4.3	95	1605
51	53	0.05	0.16	91	75	7A	61	58	42	4.2	4.4	4.0	84	1620
44	44	0.06	0.17	92	90	11A	45	68	53	4.5	4.7	4.0	79	1607
58	59	0.06	0.15	89	59	2A	31	21	32	4.2	..	..	..	1624
56	54	0.07	0.15	89	54	6A	29	22	34	4.3	..	..	..	1625
52	47	0.07	0.16	90	49	9A	31	26	35	4.7	..	..	..	1626
47	49	0.05	0.14	92	111	3A	41	44	37	4.3	14.4	12.5	80	1618
51	52	0.05	0.14	92	165	6A	55	65	43	4.4	14.6	11.9	74	1619
35	37	0.06	0.18	90	182	7A	48	72	61	5.3	14.7	12.1	75	1598
46	50	0.06	0.18	94	103	5A	42	46	52	4.6	4.9	4.7	89	1608
43	40	0.06	0.17	93	89	6A	49	51	49	4.5	4.9	4.5	85	1609
42	42	0.07	0.18	94	80	8A	51	56	44	4.7	5.0	4.2	78	1610

[c] Beater furnish for each run with clay was 85% fibers, 15% clay.
[d] Beater furnish for each run with TiO_2 was 97% fibers and 3% TiO_2.

To enable the reader to interpret the graphs more clearly, a dividing line has been drawn through the graphs. All test results above the line are considered good and all those below the line, poor.

Some of the most important tests are the pick, expansion, oil penetration, opacity, curl, tear, bursting strength, and folding endurance. It is impossible to develop a paper whose characteristics are good in all respects. In order to develop a paper with a low curl, low expansion, and a low oil penetration time, which are essential in lithographic papers, the process will usually adversely affect the strength and pick. A low pick causes much trouble in lithographic printing because the printing blanket would pick bunches of fibers from the paper and in a short time the blanket and plate would fill up, necessitating a shutdown to clean the press. According to Robert F. Reed and James J. Spevecak (*8*), "Bond strength is measured by the wax pick test, and a pick of 6 or better is generally conceded to be necessary." Using this statement as a base, a wax pick of 6A was placed on the line, therefore, any pick test shown above the line will be considered good, and any test shown below the line, poor.

The pick, bursting strength, and folding endurance correlate. When the pick increases, the bursting strength and folding endurance increases also, and vice versa. An average was taken of the bursting strength, tensile strength, tearing strength, and folding endurance for the six papers in Table III having a pick of 6A, and the average values were placed on the line also. They are comparable to those of book papers when clay is used. The other values on the median line are based on the previous investigations of offset papers by the Bureau (*9*).

RESULTS OF TESTS

Figure 1 shows the results obtained with a furnish of 75% strong soda pulp and 25% eastern sulphite pulp; beating time was $1^1/_2$ hours. This furnish, with melamine added, was found satisfactory in the previous work. Fifteen per cent of clay, an amount normally used for offset papers, softened the paper and adversely affected the desirable physical properties of folding endurance, pick, and bursting and tensile strengths. Also, the clay resulted in lint or fuzz on the wire side of the paper, the side next to the paper machine wire. The fuzz and the pick correlate—the lower the pick, the more fuzz occurs on the paper. The cause of fuzz, in most cases, is a free under-beaten stock. This gives the paper a soft surface. The greater part of the surface friction is on the wire side, and this friction causes the loosely bound fibers to fluff up on that side. The clay

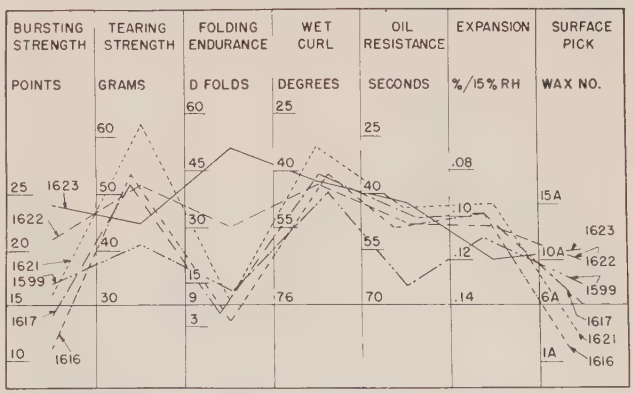

Fig. 4 Effects of melamine resin on physical properties of papers containing clay filler. Pulp: 50% soda, 50% sulphite. Beating time: $5^1/_2$ hours

1621, no M, no clay
1622, 1% M, no clay
1623, 3% M, no clay
1616, no M, 15% clay
1617, 1% M, 15% clay
1599, 3% M, 15% clay

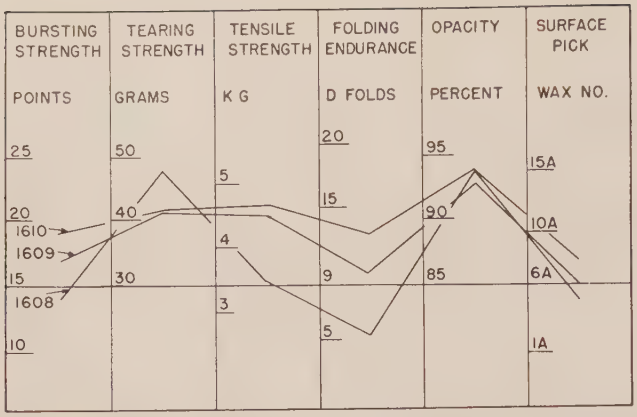

Fig. 5. Effects of melamine resin on physical properties of papers containing titanium dioxide filler. Pulp: 75% soda, 25% sulphite. Beating time: 5½ hours

1608, no M, 3% TiO_2
1609, 1% M, 3% TiO_2
1610, 3% M, 3% TiO_2

has the same effect on the paper in these respects as unbeaten free stock.

The addition of 3% melamine resin in the absence of clay (run 1564) increased the bursting strength 100%, folding endurance 300%, tensile strength 55%, and the pick about 300%, compared to the paper made without resin and clay (run 1562). However, the paper made with 15% clay and 3% melamine resin (run 1593) had physical properties comparable to those of the paper made without resin and clay (run 1562). Papers with such low physical properties would not be suitable for lithographic papers because of the tacky ink that is used in lithographic printing. The blanket would pick bunches of fibers from the paper, and in a short time the blanket and plate would be filled up, necessitating a shutdown to clean the press. The clay had little effect on the tear. The retention of clay was lowered considerably with 1% of the resin (run 1592) but only slightly when 3% was used (run 1593).

Figure 2 shows the results for a series of papers made with 50% strong soda pulp and 50% eastern sulphite pulp with a beating time of 1½ hours. Comparing the clay-free papers (runs 1540, 1560, and 1561) with the corresponding papers made with 15% clay (runs 1594, 1595, and 1596), the tests show that the clay again had a deleterious effect. However, the 3% melamine resin (run 1596) strengthened the paper containing the clay to a degree that made it satisfactory for lithographic printing, as it had good pick, low expansion, low oil penetration time, low curl, and good bursting strength. The paper made with 15% clay required 1% melamine resin (run 1595) to bring the physical properties up to those of the paper made without clay and resin (run 1540).

The melamine resin had an adverse effect on the tearing resistance in this series of papers (Fig. 2). The retention of clay was about the same as in the preceding series.

To offset the low physical properties caused by the addition of clay, fibers of the remaining runs were given the medium beating of 5½ hours with a light brushing. In runs using 15% clay without resin with 50% sulphite, 50% soda and 25% sulphite, 75% soda furnishes, the 5½ hours' beating did not improve the physical properties to any appreciable extent. The clay retention was increased somewhat.

Figure 3 shows a comparison of the effects of the 1½ (run 1595) and 5½ (run 1617) hours' beating for papers made with 50% sulphite pulp, 50% soda pulp, 15% clay, and 1% melamine resin. The figure shows that even with 5½ hours' beating the paper would be on the borderline for a good lithographic paper. However, the advantages of the latter paper were a 100% improvement in the wax pick and a minimum of fuzz. Figure 4 shows that the addition of 3% melamine resin (run 1599) made a good lithographic paper with improved physical properties compared to those of papers made with 1% melamine resin (run 1617) or no resin (run 1616). The retention of clay was better than that of the preceding two series, Figs. 1 and 2.

Figure 5 shows the results for papers made with 25% sulphite pulp, 75% soda pulp, 3% titanium dioxide, and 0% (run 1608), 1% (run 1609), and 3% (run 1610), respectively, of melamine resin; beating time was 5½ hours. The physical properties of the resin-free paper (run 1608) were below average for a good lithographic paper, but the retention of the titanium dioxide was high. The melamine resin improved the physical properties in both runs and made these papers satisfactory lithographic papers with good folding endurance, bursting strength, tensile strength, and wax pick. The melamine resin again had an adverse effect on the retention of the filler. As the amount of melamine resin was increased, the retention of filler decreased inversely; however, the opacity was not affected.

Figure 6 shows the results for papers made with 50% sulphite pulp, 50% soda pulp, 3% titanium dioxide, and 0% (run 1605), 1% (run 1620), and 3% (run 1607), respectively, of melamine resin; beating time was 5½ hours. All three runs made good lithographic papers. The paper with 3% melamine resin meets all the requirements of good lithographic papers, having high folding endurance, bursting strength, tensile strength, and pick number, and a low oil penetration time and curl.

SUMMARY

When a beating time of 1½ hours was employed, 15% clay had an adverse effect on desirable physical properties of papers made with 75% soda pulp and 25% sulphite pulp; the addition of 3% melamine resin did not result in the production of satisfactory papers. The clay weakened the paper, and made it softer, therefore fuzzier. The latter condition would cause trouble on the lithographic printing presses, filling the printing

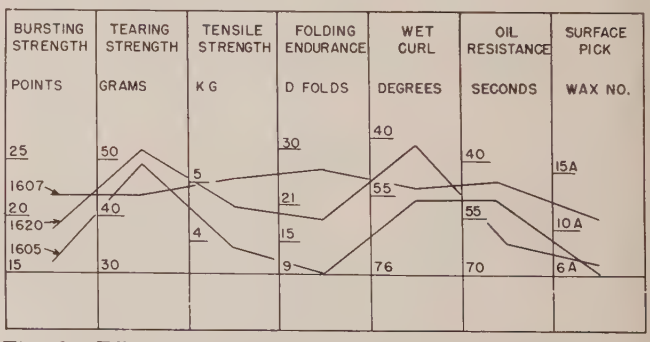

Fig. 6. Effects of melamine resin on physical properties of papers containing titanium dioxide filler. Pulp: 50% soda, 50% sulphite. Beating time: 5½ hours

1605, no M, 3% TiO_2
1620, 1% M, 3% TiO_2
1607, 3% M, 3% TiO_2

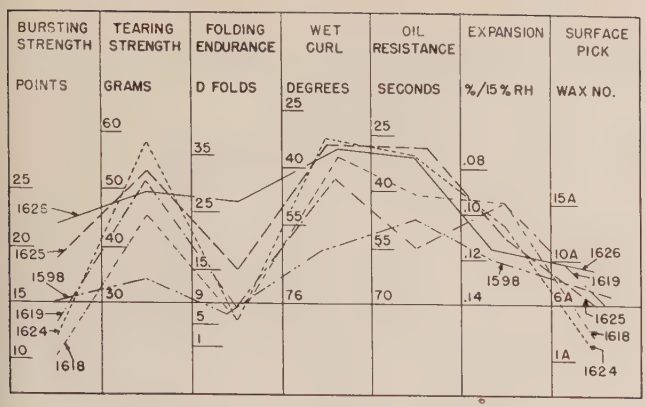

Fig. 7 Effects of melamine resin on physical properties of paper containing clay filler. Pulp: 75% soda, 25% sulphite. Beating time: 5½ hours

1624, no M, no clay
1625, 1% M, no clay
1626, 3% M, no clay
1618, no M, 15% clay
1619, 1% M, 15% clay
1598, 3% M, 15% clay

blanket and plate and thus necessitating frequent shutdowns to clean the press. However, when equal parts of soda and sulphite pulps were used, satisfactory papers resulted when 3% melamine resin was used. The retention of clay was lowered considerably when 1% melamine resin was used, but only slightly with 3% of the resin.

When the beating time was increased to 5½ hours, satisfactory papers were obtained from both 75% soda, 25% sulphite and 50% soda, 50% sulphite furnishes containing 15% clay and 3% melamine resin. Also, the clay retention was improved somewhat.

When 3% titanium dioxide was used as filler, good lithographic papers were obtained from both 75% soda, 25% sulphite and 50% soda, 50% sulphite furnishes containing 1 and 3%, respectively, of melamine resin with 5½ hours' beating time. The retention of the titanium dioxide decreased inversely as the melamine resin increased. The titanium dioxide improved the opacity considerably.

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Statistical Techniques in the Maintenance of Testing Instruments

W. E. PATTE

The problem of instrument maintenance is referred to with reference to complications arising in an integrated mill. The number and types of testing instruments maintained in operating order are listed. The location of the testing instrument maintenance function in the technical organization and its size are described. The punched-edge index cards used for record and maintenance history purposes are illustrated with description of their use. There is included a description of the use of reference paper to check agreement of various instruments of the same type throughout the mills. This is illustrated by factual data obtained on a weekly check of mullen testers, and a discussion on the use of tolerances which identify faulty instruments. Tabled are the number of tests made on each type of instrument, the tolerances used which include average results from "acceptable" instruments, and the standard deviation of single values obtained under normal mill testing conditions.

Testing procedures and testing instruments are becoming increasingly important factors in pulp and paper mills. Accompanying the use of instruments and standard testing procedures, there "tags along" an unwanted "younger brother" in the form of the maintenance problem.

Irrespective of the designer's skill or the technician's proficiency, a testing instrument can give embarrassing, and often misleading test data, if not maintained in proper order.

Dependent upon the number and diversity of testing instruments relied upon in a mill, the maintenance problem may be small or large. Nevertheless, this problem will likely increase in size in practically all mills since it is the natural expectation that more and more objective testing will be done in the mills, and furthermore, specific testing will mean a greater number of specialized testing instruments. It is certainly everyone's desire to obtain and to maintain test data which will be more and more valuable to the operating staffs in the mills.

Scope of mill operations and geographical layout are important considerations in the problem of testing instrument maintenance. If at any one mill site, both pulping and papermaking activities are carried on, or if in the extreme, multiple pulp mills, similar paper

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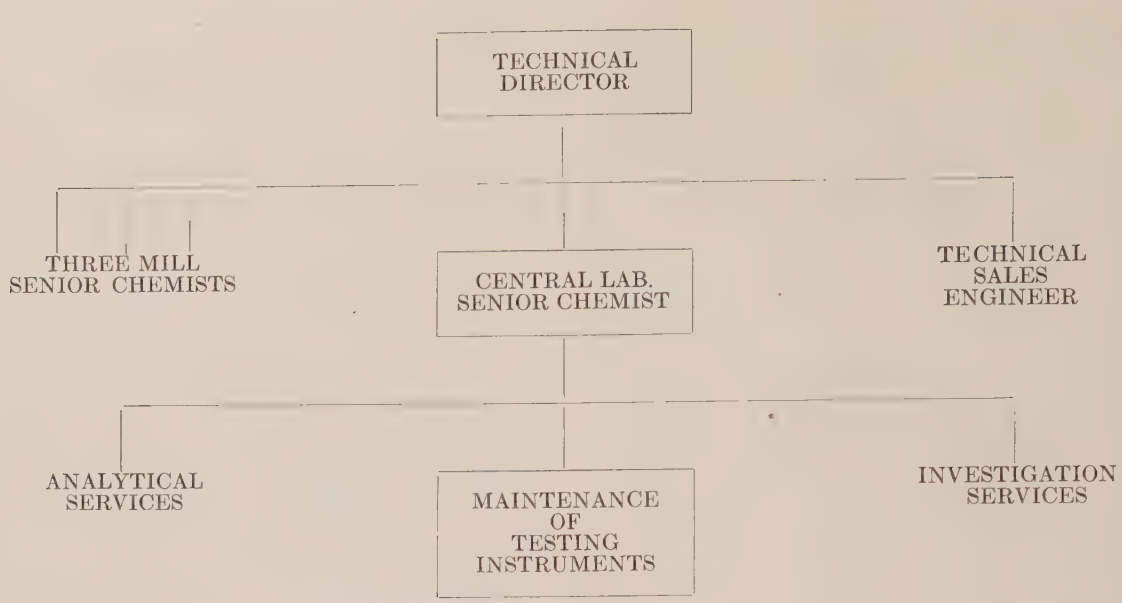

Fig. 1. Location of instrument maintenance function

machines, as well as converting operations are contained within mill property, the need for maintaining testing instruments to give reliable test data becomes quite obvious. The maintenance problem in this case is like the snake-haired Medusa, you daren't turn your back on it, but it is too frightful to behold!

If the maintenance problem persists in making its appearance, it is likely that some form of preventative inspection will be organized. This generally consists in a regular routine of looking over the instruments, trying them out through special performance trials, trying to educate testers in instrument care and in the need for reporting of faulty equipment. This routine has numerous aspects which can be greatly assisted by simple statistical techniques.

It is not the intent of this paper to cover the inspection techniques applied to testing instruments and other factors such as spare parts inventory, etc., but rather to describe those statistical techniques which have been used in attacking this difficult maintenance problem.

In Table I are listed many of the testing instruments and equipment which are maintained in order according to routine in the mills of The E. B. Eddy Co. at Hull, P. Q., Canada.

Table I. Testing Instruments and Equipment

Type	*Hull mills*	*Ottawa mills*	*Central lab.*	*Offices*	*Spare or on repair*	*Total*
Balances	11	6	8	..	5	30
Sheet driers	9	4	6	..	3	22
Calipers	5	3	2	3	3	16
Basis weight scales	7	1	1	4	3	16
Mullen testers	6	4	1	..	3	14
Mixers	4	2	3	..	3	12
Tear testers	3	3	1	..	1	8
Opacity meters	2	1	1	..	2	6
Disintegrators	3	1	2	..	1	7
Sheet machines	4	1	3	..	..	8
Sheet presses	3	1	3	..	..	7
Sizing testers	2	2	2	..	..	6
Freeness testers	3	2	1	..	..	6
Count scales	..	2	..	..	1	3
Densometers	2	2	1	..	..	5
Slowness testers	2	1	1	..	..	4
Muffles	3	1	1	..	..	5
Glarimeters	2	1	1	..	..	4
Tensile testers	1	..	1	..	..	2
Auto. samplers	..	2	..	..	..	2

DEPARTMENTAL ORGANIZATION

In view of the problem as it existed in the mills of The E. B. Eddy Co., it was recognized several years ago that a centralized testing instrument maintenance function would have to be established. This function is staffed permanently by one testing instrument man who is on occasion assisted by one to two qualified helpers. The incumbent is an especially qualified person who was trained in all testing locations in the mills before being "graduated" to his present responsibilities. He, fortunately, combines intensive testing experience with natural mechanical interest and ability.

Besides providing routine maintenance and repair services, this man also looks after the spare parts inventory, does extensive instrument overhauls in the repair shop, and turns his inventive mind to the mechanical improvement, or redesign of existing equipment. Responding through the Senior Chemist of the Central Laboratory to the Technical Director of the Company, this maintenance function is relatively free from sales, production, quality control, or other sources of influence which might otherwise bias the value of this important technical function.

It has been found to be of advantage to keep a separate record of each testing instrument. The number of instruments involved and the type of cross-indexing that is desirable justify the use of punched-edge index cards (*1*, *2*). The type used is shown in Fig. 2.

The sections of the card allow quick sorting of the complete file of cards into any one of several categories. The sections are used as described below.

Instrument Number. All instruments are assigned a code number according to the type of test performed, e.g., basis weight scales are all coded as instrument no. 1, mullen testers are no. 2, disintegrators are no. 15, ovens are no. 30, etc. By use of a sorting needle it is thus possible to drop out of the file all cards representing mullen testers, or all tear tester cards, etc.

Subclassification. This section allows differences within a main instrument type to be cross-indexed. In this way, cards for motor-driven mullen testers may be easily sorted from cards for hand-driven models, and so on.

Our main use of this section is for identification of

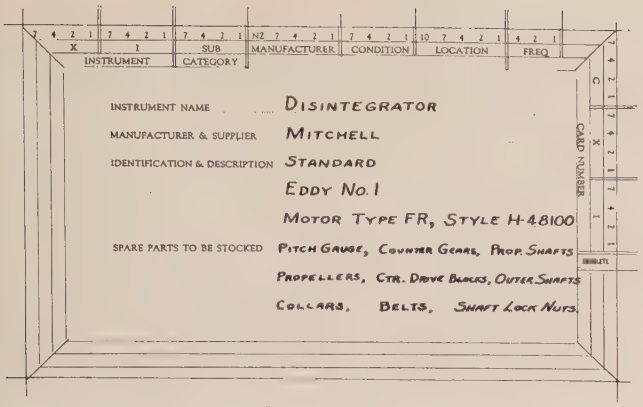

Fig. 2

motors. Electric motors are assigned main instrument no. 24, and if the motor is semipermanently connected to an instrument, then a code number for that instrument is punched into the subclassification section. This enables quick sorting of a large number of cards for electric motors to separate those referring to mullen tester motors, from cards for disintegrator motors, sampler motors, beater motors, etc.

Manufacturer. The manufacturer's name, or that of the distributor, is coded alphabetically on the cards. This allows simultaneous withdrawal of all cards representing one manufacturer's instruments. There is enough space on the card to use one hole per alphabetic letter and this would be an added convenience over the present coding method.

Condition. This section of each card refers to the testing condition of the instrument. The codes are used as follows: (1) satisfactory, (2) not standard, (3) urgent replacement, and (4) inoperative.

This section is particularly convenient when necessary to give only a very cursory inspection of instruments. The poorest instruments can be easily spotted and given what time is available. The section is also used when drawing up budgets for ensuing years. Replacements for all instruments in code no. 3 are essential, for those in code no. 2 may be desirable.

Location. This section was originally designed to show the mill location of the instrument. This was valuable in that the testing instrument man could sort the cards using this section, and when he went to a particular mill location, he could easily carry with him all the cards representing instruments in that location. In practice, however, this requires a new card to be made out at any time that a testing instrument is moved. Although the clerical effort is not severe, the continuity of record is broken and it was decided that a written record of location on the back of the card would be adequate. As a result of this change, this section of our card is not now utilized.

Frequency. This section is concerned with the frequency of preventative inspection. The codes are as follows:

1. Weekly inspection applying to primary testing instruments. These include mullen testers, basis weight scales, tear testers, opacity meters, Valley size testers, densometers, etc.
2. Monthly inspection of the remainder of actual testing instruments or equipment including freeness testers, sheet machines, sheetpresses, etc.
3. Twice-yearly inspection for inventory purposes of equipment such as balances, ovens, hot plates, etc., which seldom need repair and the conditions of which are readily appraised by the actual users.

Card Number. This is a straight numerical listing of the cards and a separate record is also maintained of the numbers. Twice yearly, the cards are counted and if one or more cards are missing, the cards are sorted to determine the missing card number or numbers. The separate record then identifies the instruments, and a new card can be inserted for each missing one in order to insure completeness of the file.

Obsolete Cards. Any card that becomes "obsolete" due to discarding of the testing instrument, replacement or renewal of the card, etc., is identified by punching at this section. Although theoretically it is not necessary to withdraw permanently an "obsolete" card from the pack of index cards, this has been found to be desirable. All "obsolete" cards are now filed in a separate location from the main pack of cards since the information on these is seldom of interest.

Instrument History. The reverse side of the card is used to record the history of the particular testing instrument. The entries were originally planned to be initialed by the senior chemist supervising the mill location of the instrument. This would have the advantage of these senior chemists being in full knowledge of work being done in their own area. This policy was found, however, to be too time consuming to be prac-

Table II. Weekly Mullen Tester Checks

Location	*No.*	*10 "Pops" single ply*	$\bar{X}$	*R*	*Remarks*
		Date: Jan. 8, 1951			
Central lab.	1	23, 24, 23, 23, 22, 24, 23, 23, 25, 24	23.4	3	O.K.
O.P.T.	2	23, 23, 25, 22, 23, 22, 21, 23, 22, 22,	22.6	4	O.K.
O.S.P. lab.	3	20, 24, 23, 20, 23, 21, 23, 23, 25, 23,	22.5	5	O.K.
Hull gwd.	7	23, 22, 23, 21, 21, 21, 23, 21, 22, 21,	21.8	2	O.K.
A mill	6	23, 23, 21, 21, 22, 21, 22, 22, 21, 22,	21.8	2	Glycol added
B mill	5	25, 25, 22, 22, 25, 20, 24, 24, 23, 22,	23.2	5	O.K.
D mill	10	21, 20, 22, 23, 20, 23, 23, 23, 22, 24,	22.1	4	Diaphragm chgd.
		Weekly average	22.5		
		Tolerance for inst. $\bar{x}$	±1.1		
			21.4 to 23.6		
Central lab.	1	49, 50, 51, 46, 50, 52, 43, 49, 52, 50	49.2	9	O.K.
O.P.T.	2	47, 50, 51, 49, 43, 47, 44, 45, 48, 46	47.0	8	O.K.
O.S.P. lab.	3	47, 48, 47, 47, 50, 48, 45, 46, 49 49	47.6	5	O.K.
A mill	6	49, 46, 50, 49, 47, 47, 47, 50, 48, 48	48.1	4	O.K.
B mill	5	45, 46, 42, 46, 48, 50, 45, 47, 50, 48	46.7	8	O.K.
Lower lab.	8	48, 46, 46, 47, 49, 47, 47, 49, 48, 48	47.5	3	O.K.
		Weekly average	47.7		
		Tolerance for inst. $\bar{x}$	±1.9		
			45.8 to 49.6		

Table III. Test Data from Instrument Surveys

Test	(1) Number of values obtained on each instrument	(2) Average value obtained	(3) Average range obtained	(4) Tolerance for instrument average	(5) Standard deviation of single value	(6) Coefficient of variation (5)/(2) × 100%
Mullen 1 ply, p.s.i.	10	20.5	3.4	±1.1	1.2	5.3
Mullen 2 ply, p.s.i.	10	45.3	6.1	±1.9	2.0	4.4
Tear 6 ply, g.	4	16.9	0.73	±0.54	0.36	2.1
Densometer, sec./100 ml.	4	19.2	2.3	±1.7	1.1	5.9
Valley size, sec./160 ma.	4	53.8	4.5	±3.3	2.2	4.1
Opacity, mma.	2	75.	0	±0	0	0

tical and entries are presently checked only by the senior chemist of the central laboratory. The present practice enables not only a convenient supervisory check on the quantity of work being accomplished but also provides a routine examination of repetitive instrument difficulties and on the need for instrument replacements.

A selected stock of bond grade sulphite paper, basis weight 37 lb. (24 × 36—500) is used in a weekly proof of primary testing instruments. The instruments checked with this paper are as follows: mullen testers, tear testers, opacity meters, densometers, Valley size testers. A stock of the paper is maintained in an ordinary metal filing cabinet in an office that is not air conditioned. In this way, the paper is stored under conditions similar to those in all but one of our instrument locations. Only in the central laboratory are well-controlled temperature and humidity conditions provided.

In preparing for the weekly proof of mullen testers, sheets of the reference paper are taken from the stock maintained, and carried from testing location to testing location throughout the mills. Single and double thickness "pops" are recorded as read off low and high-range gages, respectively, of each mullen tester. The actual results of one such weekly check are shown in Table II.

Over a period of 15 weeks, it was found that the average range of ten single pops, read off a 0 to 60 p.s.i., gage was 3.4 p.s.i. Calculating from statistical tables (*3*, *4*) commonly used, the *average* of the ten pops read off any one gage should be within ±0.308 × 3.4 p.s.i., that is, within ±1.1 p.s.i. of the grand average obtained on all gages. This tolerance ±1.1 p.s.i. is a "3-sigma" limit. An average outside these limits is taken as definite indication of a faulty gage reading. If both gages on the same mullen tester are indicated as faulty, defects in the tester itself such as air entrainment, a loose clamp, etc., are suspected. When necessary, faulty testing instruments are replaced in the mills with acceptable instruments, and the repair or recalibration work is carried out in the testing maintenance shop. Needless to note, the systematic exposure of these primary instruments to the skilled and interested eye of the testing instrument man guarantees that many incipient faults are detected and corrected or replaced before they become serious.

It is to be noted that the range of results obtained on any gage is not examined or used as an indication of erratic reading. This could readily be done, since the range of any ten single pops should not exceed 1.777 × 3.4 p.s.i., that is, 6 p.s.i. This is a logical development for the future but is not yet included in our routine.

There may be a statistical objection to the tolerance ±1.1 p.s.i. for the average for a single gage being used around the weekly average obtained on all gages. The orthodox procedure calls for this tolerance to be used around a long-term average or "standard" value. If a reference material were used, which had stability on all tests over indefinite time periods plus local stability to day-to-day temperature and humidity variations, the more orthodox procedure would be used. With paper being readily available for the purpose and being the material on which agreement of the instruments is essential, these stability requirements are not met, and the use of the "3-sigma" tolerances have been used with success around the average of all gage readings obtained each week. It is recognized that the operational limits obtained in this way are somewhat wider than those corresponding to the usual "3-sigma" limits.

Table III has been constructed on the basis of the ranges observed in the replicate tests made on each of the test instruments. Although any other mill setting up a similar control with its own paper would undoubtedly determine its own reproducibilities, the data are tabulated to report the number of tests we perform each week on each instrument. The tolerances are also shown which should encompass each instrument average and finally the reproducibility of individual tests as found from our routine testing under normal mill conditions.

CONCLUSION

In summary we may say that the statistical techniques which have assisted us in our problem of testing instrument maintenance are:

1. Punched-edged index cards which have enabled easy sorting into a number of convenient categories.
2. Instrument histories which, when combined with the above, provide a simple supervisory check on the work being performed and a routine appraisal of the condition of instruments.
3. Statistically calculated limits which specify in advance the maximum spread of test values to be obtained on various instruments of the same kind when testing a reference stock of paper. This has resulted in a knowledge of the reproducibility of test results when made under normal mill conditions.

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Acknowledgment is made of the active cooperation in the installation of these techniques by Wilfred Smith of The E. B. Eddy Co.

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Sealing Strength of Waxed Papers

R. G. CAPELL, W. P. RIDENOUR, and P. R. TEMPLIN

The importance of the sealing strength of waxed paper, nature of the thermoplastic heat seal, and measurement of sealing strength are discussed. Data are presented on the effect of fiber orientation, oil content of the wax coating, printing ink, temperature, time, and paper stiffness on seal strength. Results of a sealing strength survey of commercial waxed bread wrapping papers are presented.

One of the more important physical properties of waxed paper is its sealing strength since much of the waxed paper consumed is used for wrapping baked goods and other food packages which depend on a heat seal for final closure. The strength of this seal is an important consideration since the seal must be vapor tight and must hold together after passage through the wrapping machine and the subsequent handling. A strong seal makes possible the saving of paper by the use of less overlap in seals, renders unnecessary the use of end labels or tabs for reinforcement, and increases shelf life. Furthermore, a good sealing paper requires less rewrapping of packages at the wrapping machine. Therefore, it is clear that the sealing strength of waxed papers is a matter of importance and is worthy of study.

In this paper, we consider the nature of the heat seal, describe briefly the test for seal strength which has been used in this laboratory, and discuss several important variables. Among these are fiber orientation, oil content of the wax coating, effect of inks, sealing and testing temperature, aging time, additives, and stiffness of the paper. A report on the results of a survey of commercial waxed bread wrapping papers is also presented.

NATURE OF THE THERMOPLASTIC HEAT SEAL

The principal attractive forces which bind heat-sealed waxed papers together are:

1. Adhesive forces, mechanical and chemical, between the wax and the paper.
2. Cohesive forces within the wax layer.
3. Cohesive forces within the paper sheet.

If any one of these is weak, the seal will be weak. It appears that wax penetration is more important than attraction between the paraffin wax and the paper surfaces for producing strong wax seals. For example, the seal strength of waxed glassine paper is very low because glassine is relatively nonporous and the wax has little opportunity to penetrate and anchor itself in the interstices of the paper. On the other hand, a paper stock of greater porosity will give a seal of higher strength. This leads to the conclusion that attractive surface forces of paraffin for cellulose are small if not practically nonexistent. The dipoles in the nonconductive paper surface, in order to be effective for high seal strength, have to be operative upon polar constituents in the wax coating (*6*). Since paraffin is essentially nonpolar in character, this possibility is of no importance in a paraffin waxed paper seal on paper. It should also be noted that nonporous, nonfibrous films such as cellophane have very little attraction for paraffin (*3*). Mechanical penetration of "fingers" of wax into the porous paper is thought to be responsible for the strength of waxed paper seals, while molecular attractive forces seem to play a minor role.

If the wax coating is firmly embedded in the paper and the amount of wax is sufficient to leave an adequate coating on the outer surface, the cohesive strength of the wax comes into play. With adequate penetration into the paper base, a high tensile strength wax will give a strong seal, whereas a low tensile strength wax will give a lower seal strength. When good adhesion is achieved between paper and wax of high tensile strength the final factor which limits seal strength is the strength of the paper base itself. This is usually the practical limit of strength attainable and is evidenced by the lifting of fibers and tearing or splitting of the paper when a seal of high strength is broken.

There are two other possible forces of attraction which are worthy of brief comment. They are, the attraction of the two layers of paper for each other through the intervening wax layer and the strength of the actual fiber. The first of these is thought to be very weak or nonexistent, and the second is relatively much stronger than any other cohesive or adhesive force in a seal. The weaker bond strength of fiber to fiber, which is largely mechanical in nature, gives way first.

Glued joints and laminants have been observed to increase in strength with decreasing thickness of the glue line (*4*). This is contrary to experience with waxed bread wrapper seals which usually increase in strength with thickness of the wax coating, as shown in Figs. 7 and 8. This would indicate that, in lamination work, attractive forces exist between the base layers and act through the glue line, but that in the case of waxed papers, this force is very small or nonexistent.

When smooth nonfibrous surfaces such as polished steel, glass, and the like are brought close together with

Table I. Standard Testing Conditions

Preparation of Paper
All waxed paper is aged not less than 12 hours at 70°F. prior to sealing at 70°F.
Original seal 3 by 9 inches.
Trimmed to 2 by 4 inches
Sealing Conditions
Time, 4 to 6 seconds for a 6-inch seal
Temperature, 190 to 200°F. in room at 70°F.
Sealing pressure obtained with a load of 19 grams
Sealed with nonpigmented sides together and parallel to machine direction
Not less than six seals per test
Testing Conditions
Temperature, 70°F.
Aging period, 24 hours
Rate of peel, 5 mm. per second
Seal strength reported in grams per linear inch

R. G. Capell, W. P. Ridenour, and P. R. Templin, Multiple Fellowship of Gulf Research & Development Co., Mellon Institute, Pittsburgh, Pa.

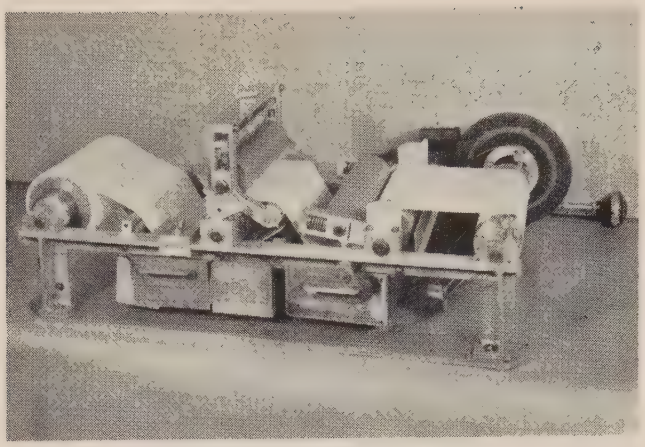

Fig. 1. Coating machine

thin layers of intervening liquids (*2*), very strong bond strengths, approaching the tensile strength of the base material, are obtained even though the distances between the surfaces are appreciable. However, this type of force is not thought to contribute to the strength of heat-sealed waxed papers because of irregularity of the paper surface and thickness of the coating.

To sum up, the strength of a waxed paper heat seal is determined by several important connecting links. They are the strength of:

1. The paper fiber itself.
2. The fiber-to-fiber bond in the paper sheet.
3. The attraction of wax for paper.
4. The tensile or cohesive strength of the wax layer.
5. The attraction of one paper sheet for another through intervening wax.

If any one of the first four is weak, the seal will be weak. Number 5 is probably not appreciable.

In the best quality bread wrapper seals, the weakest link is usually the paper itself or the fiber-to-fiber bond, and for waxed glassine, the weakest link is the wax-to-fiber bond. For some laminants, the weakest link is often the base material.

TESTING FOR SEAL STRENGTH

Many manufacturers of waxes and waxed papers have devised sealing tests. A few of these have published descriptions of their equipment and procedures (*1, 3, 5, 8*). We have studied most of the obvious variables having to do with seal strength and have

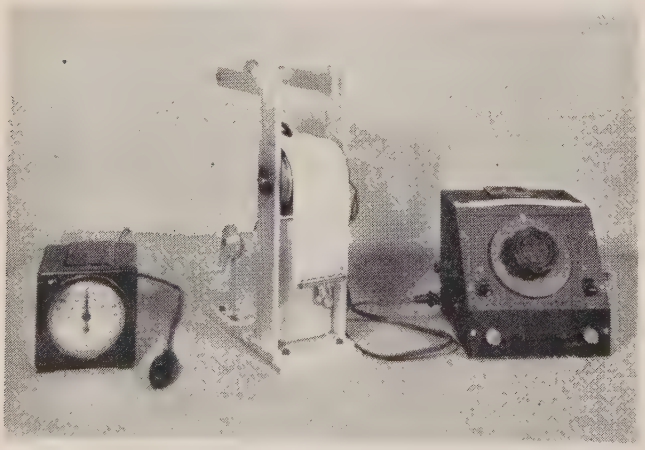

Fig. 2. Heat sealer with paper in position for sealing

Table II. Reproducibility

Number of tests	*Seal strength, g./in.*	*Average deviation* g./in.	*Average deviation* %
20	6.2	± 0.4	± 6.4
20	8.5	± 0.5	± 5.9
20	10.2	± 1.7	±16.6
20	12.1	± 1.2	± 9.9
20	20.1	± 2.4	±12.0
6	32.2	± 3.9	±12.1
6	112.4	±11.6	±10.3
6	120.1	± 6.3	± 5.2

Weight, 19 grams. Sealing temperature, 194 to 200°F. Time, 4 to 6 seconds.

established standard conditions which are in fair agreement with those selected by other laboratories, see Table I. We, therefore, will not attempt to give a detailed description of the equipment. The wax coating, sealing, and testing equipment are illustrated in Figs. 1, 2, and 3.

Reproducibility of the seal strength test as conducted

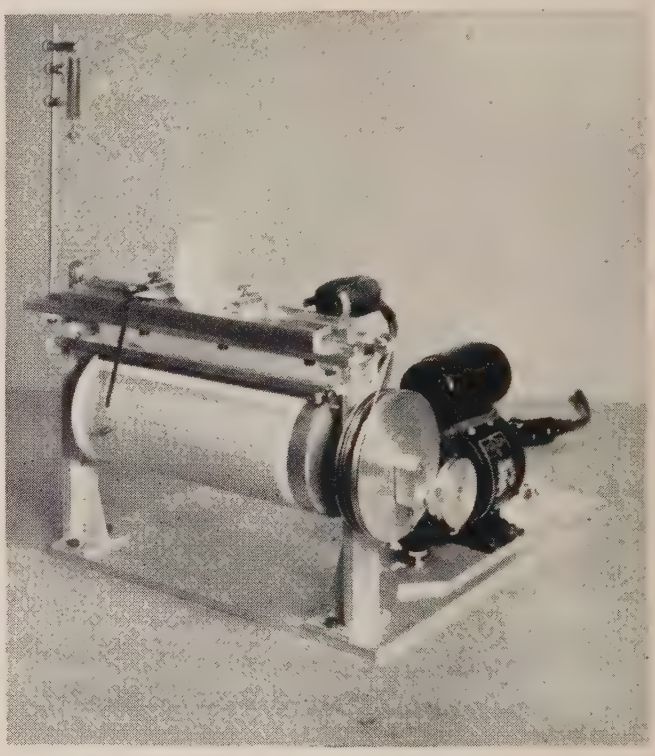

Fig. 3. Seal strength tester

in our laboratory, under conditions as given in Table I, is shown in Table II. The test is reproducible in most cases with an average deviation of ±10%.

The strength of a waxed paper heat seal is determined by measuring the force required to strip or peel the

Table III. Effect of Fiber Direction and Various Surface Combinations on the Sealing Strength of Waxed Sulphite Paper

Surface combinations	*Fiber directions* — *Fibers of both sheets parallel to machine direction*	*Fibers of both sheets at right angles to machine direction*	*Fibers of one sheet parallel to the other at right angles to machine direction*
Felt sides facing	57.6 g./in.	71.2 g./in.	67.8 g./in.
Screen sides facing	11.3	15.3	15.1
Felt side facing screen side	25.5	33.5	25.8

Deposition, 11.5 lb. per ream (24 × 36—480)

Table IV. Effect of Ink on Sealing Strength of Two Commercial Bread Wrapping Papers

Paper number	*Sealing strength, g./in.*	*Remarks*
PRT 2-133	2.0	Red colored section
PRT 2-133	19.0	Uncolored section
PRT 4-19	55.5	Uncolored section
PRT 4-19	138.5	Red inked section

two sealed sheets apart under standardized conditions as given in Table I. Figure 3 shows how this is done. The force required to separate the seal, as shown at B, is measured with a calibrated spring, A, the elongation of which, under tension from the seal, is recorded on a slowly rotating drum chart. Note that the seal is held in position for the test by two sliding paper clamps. One clamp is attached directly to the pen and is connected to the spring by a string through a small pulley under A. The other clamp is actuated by another string drawn over a larger pulley which turns with the recorder drum. Thus the small gear motor turns the recorder chart and separates the seal.

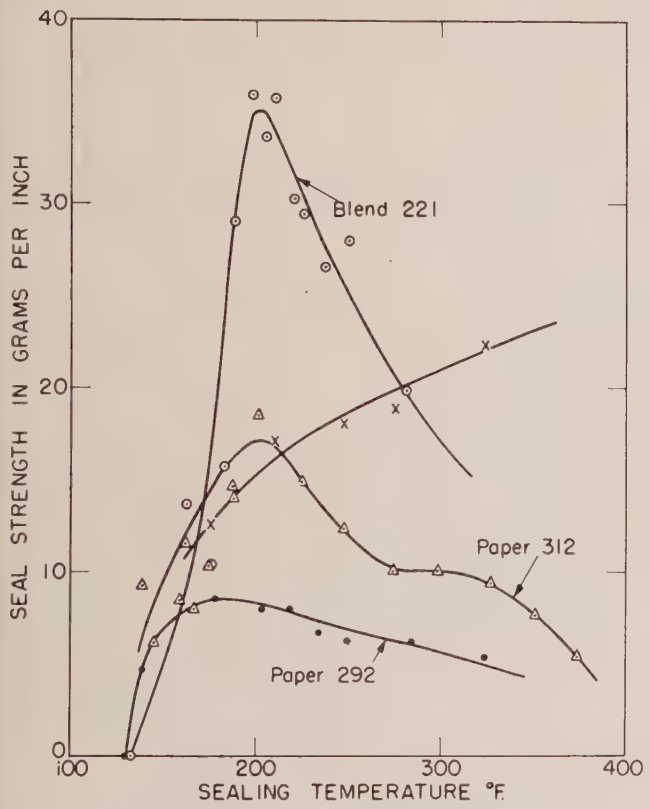

Fig. 4. Seal strength vs. sealing temperature

Although the peel test is widely used for evaluation of waxed coatings, the method has certain serious shortcomings. For example, waxed sheets of high flexibility at temperatures above 95°F. give a very irregular line on the recording chart which is difficult to evaluate. Fortunately, this type of result is rare and falls outside the range of most waxed papers. Another shortcoming of the peel test is the unknown contribution of paper stiffness to the values obtained. The fact that sealing strength apparently increases with deposition may be due to a change in stiffness rather than to an increase in actual seal strength.

Table V. Effect of Oil Content on Sealing Strength of Waxed Sulphite Paper

Oil content of 130°F. EMP paraffin, %	*Sealing strength, g./in.*
0.42	9.3
0.92	7.8
1.42	5.2
2.41	3.4
5.40	2.3

Deposition, 12.5 lb. per ream (24 × 36—480)

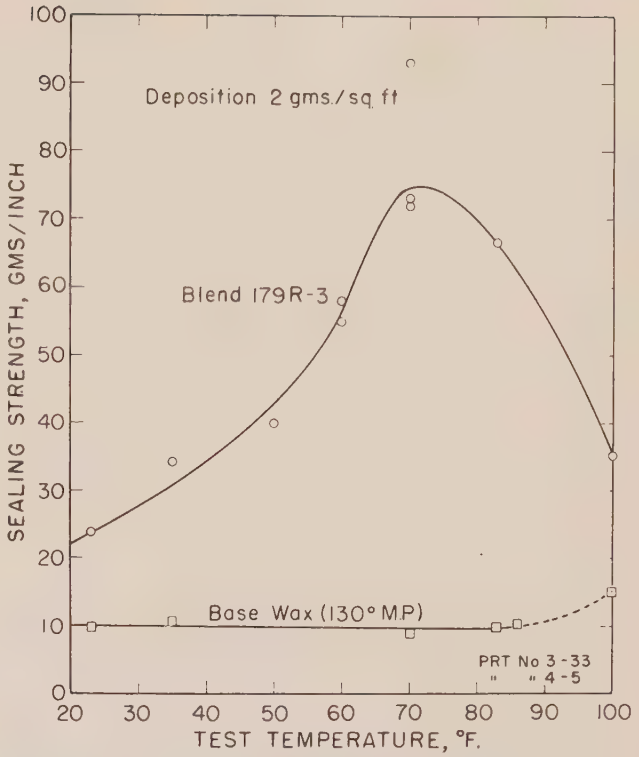

Fig. 5. Effect of test temperature on sealing strength

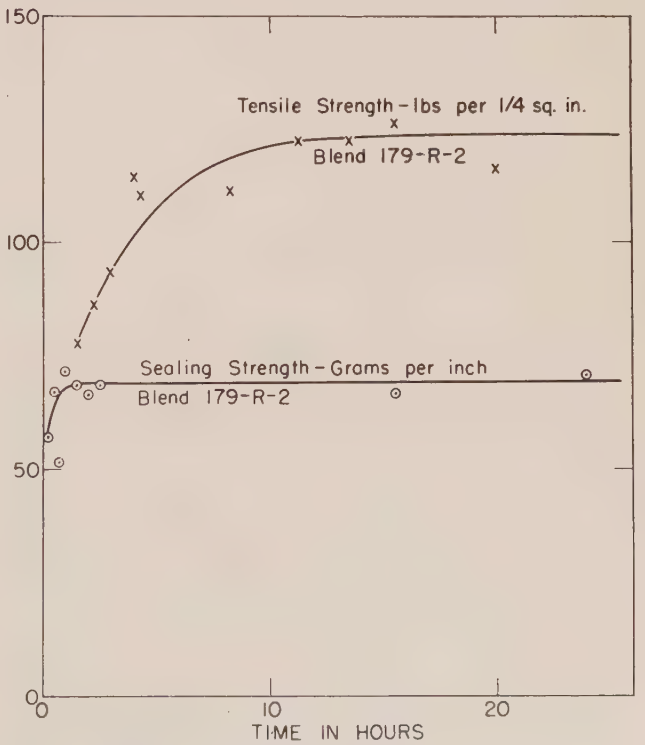

Fig. 6 Effect of aging time at 70°F. upon sealing and tensile strength

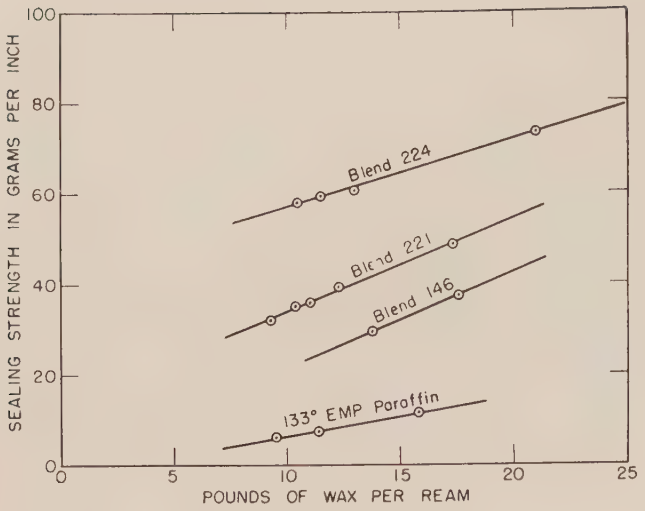

Fig. 7. Sealing strength vs. wax deposition

SEALING VARIABLES

Table III gives some information on the change in seal strength brought about by change in fiber direction as related to the effect of changing the surface in contact. The felt sides gave the strongest seal when the sheets were taken perpendicular to machine direction. The strength obtained varied from 11.3 to 71.2 grams per inch depending upon the combinations used. Fortunately, most of the stronger combinations are used in the actual sealing of a food package such as a loaf of bread. Although this variable has been mentioned by others, we had not appreciated fully its importance prior to this work.

One bit of useful information gained from this work is given in Table IV. Ink used for the design on a bread wrapper in one instance seriously decreased seal strength, and in another increased it. This suggests the need for a study of ink compositions and their effects.

It has long been known that high oil content is harmful to wax properties. In Table V, sealing strength is shown to decrease rapidly with increasing oil concentration.

Variation of the strength of a seal with sealing temperature, testing temperature, and aging time after sealing is shown in Figs. 4, 5, and 6. Most papers tested so far under our conditions reached a peak in strength near a sealing temperature of 200°F. Obviously a high, wide maximum for seal strength versus sealing temperature is most desirable. A seal should also maintain its strength at all reasonable room temperatures. In Fig. 5, it is seen that blend 179R-3 is fairly good in this respect, reaching a maximum at around 75°F. and that a reference paraffin is uniformly low. The peel test showed a rise in strength for the base wax in going from 85 to 100°F. which we questioned; however, it was reproducible, and therefore the curve was drawn as a broken line in this region. The strength of a wax seal reaches a high constant level after about 2 hours' aging time as indicated in Fig. 6. Tensile strength took longer to reach a constant value probably because of the slower cooling of the thicker tensile strength briquet. In the same wax thickness, it is probable that sealing and tensile strengths would reach a maximum together.

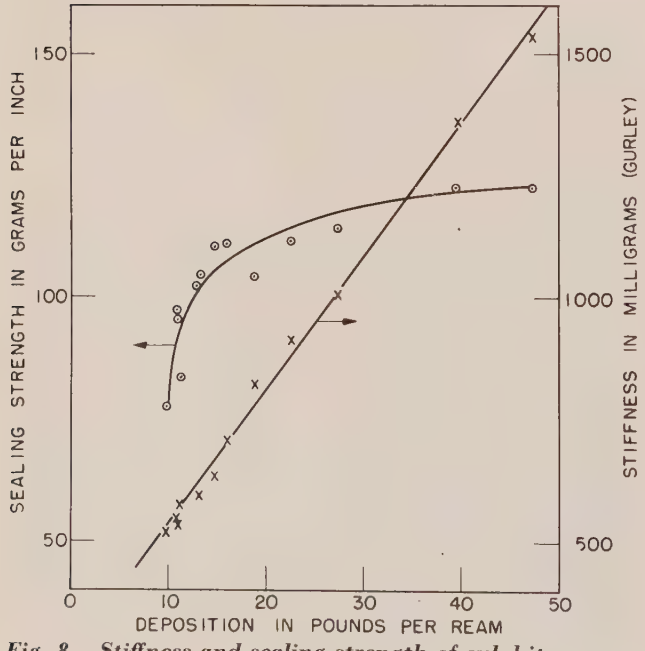

Fig. 8. Stiffness and sealing strength of sulphite vs. wax deposition

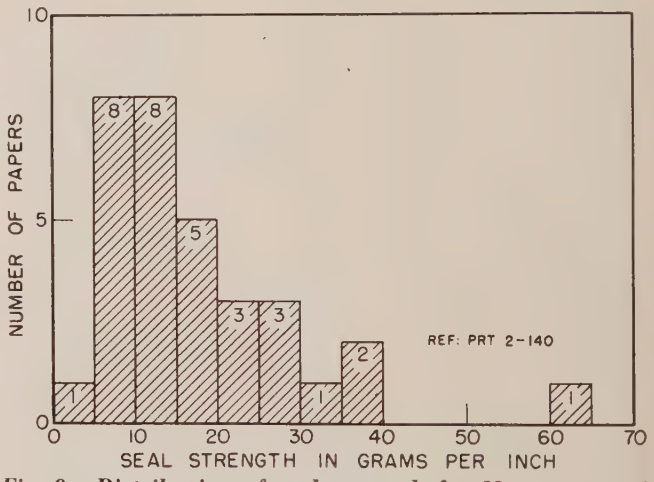

Fig. 9. Distribution of seal strength for 32 commercial waxed papers

Sealing strength appears to increase with deposition as shown in Fig. 7. The stiffness of waxed paper increases with the amount of wax on the paper as shown in Fig. 8 where the Gurley stiffness in milligrams has been plotted against wax deposition. In the same figure, it should also be noted that sealing strength increases with deposition, but approaches a maximum value of about 125 grams per inch for this composition as deposition increases. Interpretation of this result is difficult because the sealing strength was high enough, at all depositions, to cause lifting of paper fibers when the seals were peeled apart. Consequently, the values obtained were measures of the strength of the fiber-to-fiber bond in the paper rather than a measure of sealing strength for the wax coating. In order to obtain a true measure of the effect of paper stiffness on seal strength as determined by the peel test, the tests should be carried out with waxed paper having a sealing strength of less than 70 grams per inch.

BREAD WRAPPER PAPER

In order to establish a basis of comparison for work on sealing strength, samples of commercial papers were obtained from representative converters in the United States, and their sealing strengths measured. Figure 9 shows the results of the survey on 32 bread wrapping papers. Several very interesting conclusions may be drawn as a result of this brief study. Approximately half of the papers tested use additives for improvement of sealing strength. This is evident since the maximum sealing strength obtainable with paraffin wax is only about 15 grams per linear inch. Most of the papers have sealing strengths of 40 grams or less per linear inch, and the distribution shows a high percentage with seal strengths of around 5 to 15 grams.

The sealing test lends itself to evaluation of special wax compositions and sealing additives for wax, study of the effect of various types of ink upon the strength of heat seals, control of the quality of waxed papers with respect to sealing strength, technical and customer service, and fundamental investigations.

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Preservation of Fiber Insulating Board with Copper Pentachlorophenate

E. A. BEHR and A. J. HUBERT, JR.

Because of the advantages of preservation of fiber insulating board with copper pentachlorophenate over other agents the variables affecting retention are reported. The most important variables to control are the order of addition of chemicals and the pH of the pulp-slurry-chemical mixture. Fiber source or method of pulping have little effect on the retention of copper pentachlorophenate by the fiber. Depending upon the mill conditions two methods of adding the copper compound to the pulp are available, "internal" where the reactants are added directly to the pulp in the sizing box and "external" where the copper pentachlorophenate is formed in an external reaction vessel and added as the reaction mixture to the pulp.

Because of the possibilities of decay and termite attack of fiber insulating, building, and hard boards, research and testing have been done for several years on preservatives to prevent these attacks. Extensive test plot work is carried out at Bogalusa, La., and Jacksonville, Fla. Results of the work were reported (*1*) and, as far as chlorinated phenols are concerned, copper pentachlorophenate was found to offer good protection at 0.4% by weight dry. This concentration, in test plot work, has proved to be superior to 0.8% pentachlorophenol, technical, which is known to be a good preservative and is widely used by insulating board manufacturers. To date, specimen boards made by various manufacturers from different fibers and treated with 0.4% copper pentachlorophenate have been installed in test plots for 4½ years whereas most untreated specimens were removed because of decay and termite attack in 1 to 2 years.

One mill has been treating their insulating and sheathing production with copper pentachlorophenate for a year. In view of the savings in use of this preservative over pentachlorophenol it is expected more will be shifting to it.

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PROCEDURE IN BOARD PREPARATION

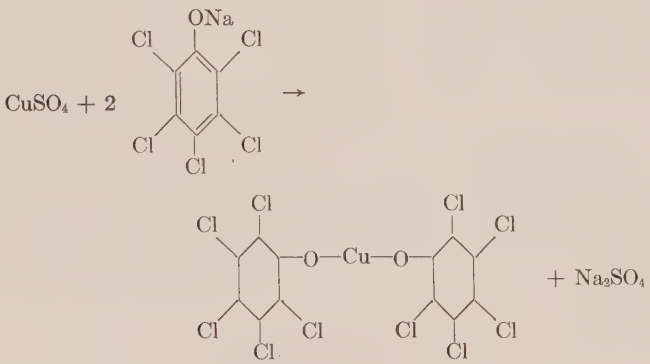
The fiberboards, studied here for retention of copper pentachlorophenate, were made in a circular mold of aluminum. Pulp samples used were manufactured in various board plants throughout the United States. In the study of retention of a certain pulp under selected conditions a quantity of the air-dry or moist stock was placed in a known amount of distilled water in a food macerator. The macerator was started and run for 1 minute for each ingredient added such as copper sulphate, Dowicide G (technical sodium pentachlorophenate), etc. In the usual trial the ingredients were mixed for 1 minute before another was added. The pulp-chemical mixture was then poured into the mold and the water drained from the mold to give a fairly consistent product. Excess solution was pressed from the pulp sheet in a screw press and the sheet was then dried in an oven at a predetermined temperature and time.

Various methods of analysis were used to determine the amounts of preservative in the boards. For total chlorinated phenols and phenates, the lime ignition method (*2*) with some modifications was used. Copper

pentachlorophenate was determined by digestion with nitric acid, reaction with sodium diethyldithiocarbamate, and photoelectric measurement of the color (*3*). To evaluate the amount of chlorinated phenols in the boards they were extracted with carbon tetrachloride and the amount determined colorimetrically by photoelectric methods.

Dowicide G is technical sodium pentachlorophenate and has been often referred to loosely as "sodium pentachlorophenate" apparently without regard for the impurities present. Label data show it to be 75% sodium pentachlorophenate, 13% sodium salts of other chlorinated phenols, and 12% inert. The "13%" consist mostly of sodium tetrachlorophenate and the inerts are water, sodium hydroxide, sodium carbonate, and unidentified substances. The above specifications are only label guarantees. Actual analyses of many batches of Dowicide G usually show that about 90% consists of sodium pentachlorophenate, sodium tetrachlorophenate, and other sodium chlorophenates, whereas only 10% is inert. Throughout this paper the word "copper pentachlorophenate" will be taken to mean the reaction product of copper ions and the total chlorophenate radicals present in Dowicide G. Thus it would include cupric tetrachlorophenate as well as cupric pentachlorophenate.

The equation for the reaction which produces the main fungicide and termite poison discussed here is as follows:



$CuSO_4 \cdot 5H_2O$ + 2 Dowicide G→

Copper pentachlorophenate + sodium sulphate
(Cu penta.) + water + unknown
(Cu tetra.)
(etc.)

By control of pH and proper concentration of reactants it is possible to attain high percentages of copper pentachlorophenate in the pulp.

Because of the possibility of incomplete reaction of the copper sulphate and Dowicide G and of reaction of the copper pentachlorophenate with hydrogen ions a number of products may be found in the board. Among these are copper pentachlorophenate, sodium pentachlorophenate, sodium tetrachlorophenate, pentachlorophenol, tetrachlorophenol, and copper sulphate. In analyzing the treated board one can extract the sample with cold water or extract the pulp with additional water after introduction of the copper sulphate and Dowicide G to the pulp slurry to remove unreacted copper sulphate. Analysis for copper ion by the colorimetric method mentioned previously, then, will indicate the true amount of copper pentachlorophenate present, provided that no rosin size was present in the pulp mixture. Extraction of the dried board sample with carbon tetrachloride, as mentioned above, removes the pentachlorophenol, and tetrachlorophenol for determination and calculation as pentachlorophenol. Application of the lime ignition method for total chlorine in the board sample and subtraction of the values found for other chlorinated phenols and phenates gives the amount of sodium pentachlorophenate and sodium tetrachlorophenate present. In all cases the penta- and tetrachlorophenols or phenates are calculated as the penta compound.

As far as is known the experimental work leading to patents on incorporation of pentachlorophenol in fiberboard and in treatments for test plot exposures and fungicidal work has all been done with technical sodium pentachlorophenate.

FACTORS AFFECTING RETENTION OF COPPER PENTACHLOROPHENATE BY PULPS FOR FIBER INSULATING BOARD

A. Effect of Order of Addition of Chemicals

If it be agreed that the best point for addition of the copper sulphate and Dowicide G to the pulp slurry is as near to the headbox as possible, we are confronted with the problem of order of addition of these ingredients as well as the size, alum, and any others.

When rosin size is favored the copper sulphate and Dowicide G must be added before the size and allowed to mix with the pulp and react. Otherwise the size will react with the copper sulphate to produce copper resinate leaving insufficient copper to form the pentachlorophenate. If alum is added before the copper sulphate or in any order where the copper sulphate and alum are present in the pulp together when the Dowicide G is added, pentachlorophenol or perhaps aluminum pentachlorophenate will form in preference to copper pentachlorophenate. This is probably a pH effect as will be mentioned later. Wax or paraffin size may be added at almost any convenient place, however, since it doesn't interfere with the reaction between copper sulphate and Dowicide G. Data are not given here to show the extent of the reaction between rosin size and copper sulphate but our laboratory found unexplainably high retentions of copper compounds when

Table I. Order of Addition of Chemicals to Boards Shown in Tables II and III

Board no.	*Fiber source*	*Order of addition*
1	SYP	Dowicide G, copper sulphate, alum, rosin size
2	SYP	Wax sizing, Dowicide G, alum and copper sulphate added simultaneously
3	SYP	Dowicide G, copper sulphate
4	SYP	Flour, corn starch, Dowicide G, copper sulphate added externally
5	SYP	Alum, wax sizing, copper pentachlorophenate mixed externally with 2% Marasperse N
6	WS	Alum, wax sizing, copper pentachlorophenate formed externally
7	SYP	Copper pentachlorophenate formed externally
8	WP	Copper pentachlorophenate (formed externally) wax size, alum
9	SYP	Copper sulphate, Dowicide G, rosin size, alum
10	SYP	Wax size, copper sulphate, Dowicide G
11	SYP	Wax size, copper sulphate, Dowicide G

SYP = Southern yellow pine groundwood. WS = Douglas-fir and western hemlock Asplund pulp. WP = Waste paper.

Table II. Results of Addition of Copper Pentachlorophenate to Various Pulps at Different pH Values

Board no.	pH of pulp slurry before chemical addition	pH of final mixture	Amount of copper sulphate added to pulp in relation to Dowicide G	Retention of copper pentachlorophenate, % of theoretical
1	4.9	3.85	146% excess	73
2	4.9	3.81	Equational	18
3	4.9	5.19	25% excess	94
4	4.9	5.19	25% excess	100
5	4.9	4.80	Equational	71
6	5.1	4.80	Equational	76
7	4.9	4.83	Equational	15
8	4.9	4.5	Equational	63
9	5.7	3.7	Equational	56

an excess of copper sulphate was used over that needed for complete reaction with the Dowicide G.

In Table I, board no. 1 was treated by adding the chemicals in the following order: Dowicide G, copper sulphate, alum and rosin size. Because of the excess of copper sulphate used over stoichiometric quantities, copper resinate also was formed in the board, and copper pentachlorophenate could not be determined by the colorimetric method. Instead the lime ignition method was used for the copper pentachlorophenate. This would also include any unreacted sodium chlorophenates and pentachlorophenol formed in the reaction. The analysis for copper, when calculated as copper pentachlorophenate, gave unexplainably high values, indicating that a copper-rosin size reaction product had formed.

Board no. 2 was made from the same pulp source, southern yellow pine groundwood, as board 1 but wax size was used. Also Dowicide G was added before the alum and copper sulphate which were added simultaneously. It is to be noted that the retention of copper pentachlorophenate in board no. 2 is only 18% of theoretical compared to 73% where the order of addition allowed reaction of copper sulphate and Dowicide G before the alum was present. The best order, then, is Dowicide G or copper sulphate added in either order followed by sizing and alum.

B. Effect of Quantity of Reactants

In Table IV will be found the results of addition of copper sulphate and Dowicide G to pulp samples to form boards and study the effect of varying the quantity of copper sulphate present. It will be seen that there is very little increase in retention of copper pentachlorophenate by the boards with increasing excesses of copper sulphate. Since no effort was made to control the final pH of the reaction mixture, the slightly better retentions with excess copper sulphate may be due to this effect. This is discussed under D. Since an excess of a common ion will suppress solubility of a sparingly soluble substance, it might be advisable to add a slight excess of copper sulphate in the reaction, but good retentions are possible with stoichiometric amounts. Furthermore, since Dowicide G may vary from batch to batch by a per cent or two in the amount of sodium pentachlorophenate it contains, a slight excess of copper sulphate would assure complete reaction. Copper sulphate being the less costly reactant, it would be used as the excess chemical.

Table III. Treatment of Southern Yellow Pine Groundwood Stock with Copper Pentachlorophenate Using Stoichiometric Amounts of Reactants and Drying for 36 Minutes at 182°C.

Board no.	pH of pulp slurry before chemical addition	pH of final mixture	Retention of copper pentachlorophenate, % of theoretical	Retention of other chlorinated phenols, % by weight	Copper in 3500 ml. of filtrate, p.p.m.
10	5.85	5.68	83.3	0.09	0.28
11	5.1	6.3	83.9	0.04	0.32

C. Effect of Place of Formation of Copper Pentachlorophenate

It is possible in the treatment of pulp to form the copper pentachlorophenate in a separate reaction tank and add a suspension of it to the pulp. It should also be possible to add a finely powdered, dry copper pentachlorophenate preparation to a pulp slurry. The former method of addition is described as "external addition." To date most of the experimental work on resistance of the treated boards to biological deterioration has been done with fiberboard treated by the more conventional method of addition of the copper sulphate and Dowicide G directly to the pulp suspension with reaction occurring in the pulp. This is referred to as "internal addition."

Table IV. Effect on Retention of Copper Pentachlorophenate by Southern Yellow Pine Groundwood Using Varying Ratios of Reactants

Board no.	Ratio of moles of Dowicide G to moles of $CuSO_4 \cdot 5H_2O$	Retention of copper pentachlorophenate, % of theoretical
1	2:1	87
2	2:1.25	88
3	2:1.5	93.5
4	2:1.75	94.6

Where internal addition is used and enough time can be allowed between introduction of the Dowicide G and the copper sulphate to the pulp, good distribution of the copper pentachlorophenate is likely. Since field exposure tests have shown this method of treatment to be successful it is recommended over external addition where it can be used. However arsenic trioxide, added to pulp as a slurry in water, has been used successfully to treat fiberboard commercially for some time so it is reasonable to assume that external addition of copper pentachlorophenate should also give good results. Evidence (*4, 5*) for adsorption of both sodium pentachlorophenate and pentachlorophenol exists. Copper pentachlorophenate is probably also adsorbed by the pulp fibers. One mill now treating their production with copper pentachlorophenate adds the Dowicide G and copper sulphate to tanks containing a starch-wheat flour binder which is used also in untreated board. The copper pentachlorophenate precipitates on the starch and flour particles which, in turn, are well dispersed throughout the pulp. Board no. 4 was made by the precipitation of the copper pentachlorophenate on a starch-wheat flour mixture and addition of this to southern yellow pine groundwood and Asplund pulp. Retention was 100%. The pH of 5.2 of the final pulp mixture of boards nos. 3 and 4 explains the much higher retention here than in boards nos. 1 and 2. It should be noted that internal or external addition gave comparable retentions. In the treatment of board no. 5 a

suspending agent, Marasperse N, in the amount of 50% of the copper pentachlorophenate was used. Thus a 6% suspension was dispersed by half as much suspending agent. This mixture showed no settling after 6 hours whereas 6% mixtures of Dowicide G and copper sulphate without the Marasperse begin to settle shortly after preparation. However, more dilute suspensions, say 2%, remain dispersed without any agent for long periods. It is also possible to prepare colloidal sols of copper pentachlorophenate which will remain suspended almost indefinitely by using concentrations of reactants in the neighborhood of 0.1%. These sols are precipitated by foreign ions, especially multivalent metallic ones. The use of sols would be possible but concentrations of copper pentachlorophenate are so low that excessive amounts of water would be needed to suspend them, and pulp consistencies would be interfered with. As near as can be told from laboratory data, 2 to 2.5% solutions of Dowicide G and copper sulphate give best results. It should be borne in mind, though, that commercial equipment might allow higher or lower concentrations to be used with equal success.

"External addition" was also used with board no. 6 but the pulp source was Douglas-fir and western hemlock Asplund fiber. Here the retention was about the same as for that board made with another pulp stock. Board no. 8 was made from waste paper stock with the copper pentachlorophenate added externally.

As was mentioned above, "internal formation" is to be preferred since more is known about the performance of board so treated, although tests are now under way to evaluate externally treated board biologically. There are some cases, though, where internal formation cannot be conveniently used. For example, the arrangement of valves and piping might be such that the Dowicide G could not be added in a place where assurance could be had that the copper sulphate would react completely with the Dowicide G before the latter contacted the alum. Another instance where external formation would be indicated occurs when the acid content of the pulp is so high that pentachlorophenol is formed rather than copper pentachlorophenate when Dowicide G is added to the pulp-copper sulphate mixture. This case is not so common, even though the pH of the pulp is low, as will be explained later.

It appears, then, that either external or internal formation will give equally good retentions in fiber insulating board. Basing our evidence on similar cases we would think that protection offered by the external formation of copper pentachlorophenate would be equal to that of internal formation.

D. Effect of pH on Retention

By experimenting with solutions of copper sulphate and Dowicide G in pulp-free trials it was found that pH had a considerable effect on the color and amount of precipitate formed. It turned out that a pH above 5.2 gave the highest amount of copper pentachlorophenate. It was further noticed that once the pH of the reaction mixture was lowered from 5.2, raising it did not result in reformation of copper pentachlorophenate. A 3% solution of Dowicide G in distilled water has a pH of 9.8 and a 1.2% solution of copper sulphate pentahydrate has a pH of 4.3. When stoichiometrical amounts of these solutions are brought together the final pH is about 6.7. If a 25% excess of copper sulphate is used in this reaction the final pH is about 6.1. There is some evidence that the pH range 5.2 to 5.8 is optimum although retentions above 5.8 seem to be but little smaller than between 5.2 to 5.8, but below 5.2 the amount is considerably reduced.

Measurement of the pH of a pulp slurry, before addition of any chemicals, will not necessarily indicate whether the final pH of the mixture, after addition of Dowicide G and copper sulphate, will be in the optimum range. Nor will it tell whether the Dowicide G will precipitate due to acidity of the pulp, upon its addition. This is the case because of the small amount of excess alkali present in Dowicide G which will, in most cases, neutralize the acid in the pulp. Because of this basicity of Dowicide G solutions most acid pulps do not interfere with "internal addition" of copper pentachlorophenate. If the amount of titrable acidity in the pulp is actually great, however, Dowicide G would precipitate as pentachlorophenol even if copper sulphate were added to the pulp prior to the Dowicide.

In the case where a fiberboard mill contemplated treatment of their board with copper pentachlorophenate the most reliable method for determining the effect of pH on "internal addition" would be to add the proper amounts of Dowicide G and copper sulphate to some of their mill run pulp slurry, form a sample board, and analyze the board for copper pentachlorophenate and pH after addition. The retention of copper pentachlorophenate should be 80% of theoretical or better, if the acidity is to be considered of no consequence. A quicker way, but not so reliable, is to add the appropriate amount of Dowicide G to give 0.4% retention of copper pentachlorophenate to the liquor filtered from the pulp. If "internal addition" is to be possible no precipitate should form, and the final pH should be above 7.2.

The effect of final pH of the pulp-chemical mixture can be seen by referring to the data in Tables II, III, and IV. It will be seen that the highest retentions of copper pentachlorophenate are in those board samples whose final pH was in the range 5.2 to 5.8, other conditions being equal. Boards nos. 2, 7, and 9, Table II, show the effect of low pH on retention especially well.

Table V. Retention of Copper Pentachlorophenate by Various Kinds of Fiber Stock

Fiber stock	*Final pH of pulp slurry after chemical addition*	*Amount of 1% alum needed[a] to obtain pH shown, ml.*	*Retention of copper pentachlorophenate, % of theory*	*Pentachlorophenol in board, % by weight*	*Copper in 3500 ml. of filtrate, p.p.m.*
Waste paper	5.6	8.5	95	0.02	0.10
Douglas-fir and western hemlock Asplund pulp	5.6	7.0	88	0.03	0.09
Aspen groundwood	5.6	0.0	84	0.04	0.12
Pine and other softwood Asplund pulp	5.5	1.0	85.5	0.06	0.30
Southern yellow pine groundwood	5.7	0.0	86.5	0.05	0.30

[a] Alum shown was added to 500 ml. of 3% pulp slurry.

Board 1 had a low pH but shows a good retention of copper pentachlorophenate because the method of analysis also included the copper resinate formed and is, therefore, somewhat misleading. The pulp-chemical mixture for board no. 7 was allowed to remain in contact with a buffer solution of pH 4.8 for 2.25 hours. Evidently the length of time of exposure of the copper pentachlorophenate formed in the pulp to undesirably low pH is important.

E. Effect of Pulp Source on Retention

It can be seen by referring to Table V that the kind of pulp or the method of pulping has little effect on the retention of copper pentachlorophenate. Aspen groundwood, southern yellow pine groundwood, Douglas-fir and western hemlock Asplund mixture, waste paper, and an Asplund pulp made from a mixture of softwoods, mainly southern yellow pine, were treated internally with copper pentachlorophenate. All final pulp-chemical mixtures were adjusted to nearly the same final pH by addition of alum. It will be noted that this varied and depended mostly on the nature of the pulp. In this same table will be noted the amounts of unreacted copper sulphate, and pentachlorophenol, in the board, and the amount of copper in the filtrate from the treated pulp.

Samples of southern yellow pine groundwood were also treated with externally formed suspensions of of copper pentachlorophenate and arsenic trioxide. Large quantities of bagasse board are treated annually with arsenic trioxide but none of this pulp was available at the time of test. Retentions of copper pentachlorophenate were about 88% and about the same for the arsenic trioxide. Similar retentions were found where the copper pentachlorophenate was formed internally and the arsenic trioxide added later as a slurry or where the copper sulphate and Dowicide G solutions were added to the arsenic trioxide suspension prior to introduction into the pulp.

QUANTITIES OF CHEMICALS NEEDED FOR BOARD PRESERVATION

Reference to the equation for formation of copper pentachlorophenate and consideration of the purity of these reactants as well as retentions to be expected leads to the following. Boards should be treated with at least 0.4% copper pentachlorophenate to give protection from decay and termites, as is indicated in test plot exposures of treated insulating boards to date. To protect 1 ton of moisture-free fiber would require 3.35 pounds of commercial copper sulphate pentahydrate and 7.76 pounds of sodium pentachlorophenate, if it were pure. However Dowicide G is stated to contain 85% sodium chlorophenate and the reaction forming copper pentachlorophenate can only be expected to give 85% of the theoretical yield in the board. Considering these points we find 10.14 pounds of Dowicide G and 3.94 pounds of copper sulphate are necessary to give approximately 0.4% retention. By increasing retentions the quantity of both reactants could be reduced. Analysis of the boards treated by "external formation" on wheat-flour starch mixture gave 100% retention in the laboratory and boards treated commercially were also found to have high retentions. Where white water is recirculated it should be possible to effect further savings, but account will have to be taken of the effect of low pH due to alum, and only external formation of copper pentachlorophenate may be possible unless the pH can be economically raised.

LOSSES OF COPPER PENTACHLOROPHENATE IN BOARD TREATMENT

Low retentions are discussed elsewhere, chiefly under the section of effect of pH on retention, and explanations given there will apply here. Copper pentachlorophenate probably undergoes hydrolysis at low pH values to form pentachlorophenol. Very little copper pentachlorophenate breaks down during the drying process since only about 3 to 6% pentachlorophenol is found in the dried boards. This may arise also from hydrolysis during the slurry stage or from side reactions during the formation.

Sample boards have been dried 16 hours at 212°F., 17 hours at 221°F., 1½ hours at 293°F., and 36 minutes at 360°F. with retentions still in the order of 85%. Although there appears to be some hydrolysis when copper pentachlorophenate is prepared in the usual laboratory way and dried in an oven, apparently this is not the case when it is dispersed throughout a fiberboard.

When making the sample boards one half was oven dried and the other half of the board air dried. Both sections were then analyzed during the early part of the work and it was found that there was no measurable loss of copper pentachlorophenate due to drying.

All reactions were carried on at room temperature, about 85 to 90°F. Where pulp slurry temperatures are higher, more loss will occur due to increased solubility of copper pentachlorophenate.

CONCLUSIONS

1. Retentions of copper pentachlorophenate of 85% or better can be obtained in fiberboards by using stoichiometrical amounts of reactants.

2. The copper pentachlorophenate can be added to the pulp slurry after formation in an external reaction vessel or it may be formed by introduction of the copper sulphate and technical sodium pentachlorophenate solutions in the pulp slurry.

3. Best retentions are obtained if the final pH of the pulp slurry-chemical mixture is 5.2 or higher.

4. Pulping method or fiber source have little effect on retention of copper pentachlorophenate.

5. Drying conditions approximating commercial practice in fiberboard manufacture do not reduce retention appreciably.

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Microbiology of Certain Paper Food Containers

ERNEST REED

A presentation of the summation of the data of the microbiological studies of certain paper food containers and that of paper materials out of which such food containers are fabricated.

INTEGRATED with the Institute of Industrial Research at Syracuse University, the Department of Plant Sciences in the University has a program of service and research with manufacturers of paper and paper products. This program has been going on for a little over three years. A portion of the attention is centered on containers and products of paper and paperboard specifically intended for use in connection with food and it is concerning this portion of the work to which the following remarks and data pertain. It is in no wise intended that this paper is a complete review of the program in all its phases but it is only intended that we shall furnish here to TAPPI a block of data which we think presents a fair picture of the condition of paper and paper containers which are used for food purposes from the microbiological point of view.

Consider the products and paper samples we received from 33 plants over a 12-month period with the samples coming from the various plants on a calendar schedule every 3 months. This block of study involves 999 samples which call for 67,130 tests. Of these, 1,884 tests were of paper by the disintegration method. The remaining 65,246 pertain to the surface of the finished product which would come in contact with the food. The various methods were as follows: contact, 14,568; rinse, 39,559; swab, 11,119.

The methods used were from "Standard Methods for the Examination of Dairy Products," Ninth Edition, 1948, published by the American Public Health Association. There is no intention of discussing the pros and cons of the values of these methods in this paper.

The products tested in this analysis include the many various types produced by these 33 plants. The containers range from 1-ounce capacity to 32 ounces and the area tested ranges from 53 to 478 sq. cm. The conclusions of the studies of the surface tests are as follows:

1. There is no correlation between the microbiological count and the area or volume of the tested units. The counts of the smallest units are comparable to those of the largest units. This indicates the probability that what count there is is due to the converting and handling processes and not to the material of which the units are made.

2. The mean of the colony frequency is 6.5.

3. Less than 5% of the units will exceed 19.5 colonies per container. Less than 1% will have 32.5 colonies per container. Over 99% of all of the containers of all sizes and shapes will have less than 35 colonies per container.

4. From another block of data wherein only the contact method was used on surface areas varying from 13 to 60 sq. cm., out of 12,338 samples, 38 had a count of over 5 and 12,300 had a colony count of less than 5.

5. Our arrangements with the cooperating companies provide that these products shall be received by us from them in the same way as their customers receive these products and these data clearly indicate that insofar as the products of the 33 above-mentioned plants are concerned, they are received by their customers in satisfactory condition from the point of view of the frequency of microbiological flora.

6. The types of flora that do occur are of no concern as has been reported by others frequently, and since there have been no *E. coli* present.

7. The data from the disintegration tests of the paper materials do not lend itself to any clear-cut conclusions such as the above data provide. The tests show a high degree of fluctuation and do not fall into any organized pattern. There is no correlation between the microbiological count of the materials through the use of the disintegration test and the microbiological counts secured from the rinse and contact methods of the finished product. In other words, we are not presenting a study of this bracket of the work at this time. There has been a great deal of attention given to a certain figure of 250 colonies per gram of disintegrated stock and without entering into a discussion of the pros and cons of that, we can submit the simple fact that out of a block of tests consisting of 962 samples, 50 of the samples showed tests in excess of 250 colonies. However, when one considers that some samples are such that it is impossible to make a count because of the frequency of the colonies in the plates, we feel that our studies are such that we cannot properly present them on this matter as yet. The number of variables that enter into this study are considerable.

DISCUSSION

G. A. CRUICKSHANK (National Aluminate Corp., Chicago, Ill.): This paper confirms what we have all believed for many years, namely, that the bacteria present on paperboard as it comes from the drier rolls are without significance from the viewpoint of public health.

The lack of correlation between the microbiological count and the area or volume tested is interesting, but would appear to be due to the inherent inaccuracies encountered in evaluating plate counts where the number of colonies is very small, as in the present case. It should be pointed out, also, that in using the rinse method all of the bacteria present in the container are not removed by a single rinse. If several rinses are employed it would not be uncommon for one or more of the later rinses to yield as many or even more colonies as from the first rinse. The reason for this action is

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not clear, but may be connected with the amount of agitation applied during the rinsing operation.

A somewhat similar error occurs in the contact method where the colony count does not necessarily represent the growth from each separate organism on the surface of the board but rather from clumps of several bacteria located in various isolated spots on the paper. The true number of bacteria present therefore, is always greater, and may be many times that indicated by the colony count in this method.

The fact that the counts obtained using the disintegration test do not correlate with those from the rinse and contact methods is not at all surprising. Counts obtained by disintegrating the board will tend to vary with the thickness of the board, the thicker boards showing the lower counts. This is due principally to the longer period of contact with moist heat, obtained when passing the thicker boards over the dryer rolls. No such variation is to be expected in the numbers of bacteria on the *surface* of boards of different thickness since the degree of sterilization is so effective in any case.

It would be interesting to know about what proportion of the bacteria isolated could be ascribed to the converting and handling process as compared to those present in the sheet immediately after the drier. My own feeling would be that all of the nonsporeforming bacteria present (if any) would originate during the converting process. Sporeformers on the other hand could originate either with the manufacturer or the converter.

The problem of sporeformers appears to be the great stumbling block in the path of understanding between the public health authorities and the paper industry. All procedures up to the present time appear to be based on the premise that the magnitude of the bacterial count of food boards is a measure of the sanitary conditions under which the board is produced. While such a premise holds true in general, and I would like to emphasize that this is only "in general" for milk and certain other food products, it is absolutely untenable in the case of food board because the only bacteria surviving the drying process are the heat resistant types of the sporeforming variety. The mill system may be literally swarming with bacteria of many kinds, a considerable amount of slime may be present in the vats and on the machine, and yet in the absence of appreciable numbers of these particular sporeforming bacteria in the system the board will usually emerge from the drier rolls as an essentially sterile product.

Manufacturers of food board have, therefore, a highly specific problem to solve and that is to rid the mill system of sporeforming bacteria. Fortunately, these bacteria are not nearly as resistant to chemical treatment as to heat and they are rather easily controlled with appropriate treatment. This treatment should be specific for the sporebearing bacteria and is not necessarily the same treatment as that used for controlling s ime in the system.

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A Rotary Pick Tester

WALTER W. ROEHR

In the printing of both coated and uncoated book papers, the proper pick resistance or surface bonding strength is necessary if optimum printing quality is to be obtained. Until recently the available test methods have not been entirely satisfactory, particularly for some types of pick and on certain types of paper. The present development was undertaken in an effort to construct an improved testing unit and is based, in part, on bonding strength work done by The Institute of Paper Chemistry (Instrumentation Program Report No. 31, Part III). The instrument was designed to simulate to some extent, actual printing procedures and to provide sufficient control of the known variables to permit keeping the tester in statistical control. Fundamentally, it consists of a stationary, rubber-covered impression roll (to which one or more test samples are attached) and a movable black Carrarra glass plate carrying a uniform film of the picking fluid. This arrangement is similar to that of a flat bed cylinder printing press. The plate is driven by a specially designed cam which produces a variable speed proportional to the distance traversed. For the picking medium, a Newtonian fluid, such as blown castor oil, is preferred. On the theory that the tensile stress applied to the sample surface is proportional to the viscosity of the fluid used and to the speed with which it is pulled away from the surface, a judicious choice of speed range and viscosity permits one to obtain a pick number for every sample run. Among the variables which were found to influence test results are relative humidity, temperature, film thickness, and nip pressure.

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The pick resistance or surface bonding strength required of a sheet of printing paper varies widely depending upon the end use. In general, most rotogravure printing and monotone letterpress printing with soft inks can be done satisfactorily on relatively weak papers. For tackier inks, such as are used in four-color process work, the pick resistance has to be somewhat better, while most offset work requires an exceptionally well-bonded sheet. When a paper surface fails to come up to the required strength, the printing job suffers from increased cost and lowered quality. On the other hand, a sheet which is overdesigned from a pick resitance standpoint is not only costly to produce but frequently also suffers in printing quality, such as poorer halftone reproduction, slower drying, etc. It is highly desirable, therefore, to strike a proper balance between pick resistance and other sheet properties.

There are various types of picking, all of which are detrimental to good printing quality. Fiber pick or "fuzzing," where individual fibers, loosely bound, are pulled off the sheet, occurs primarily on uncoated or lightly coated papers. Coating pick, where small particles of coating are lifted off by the ink, is due to the

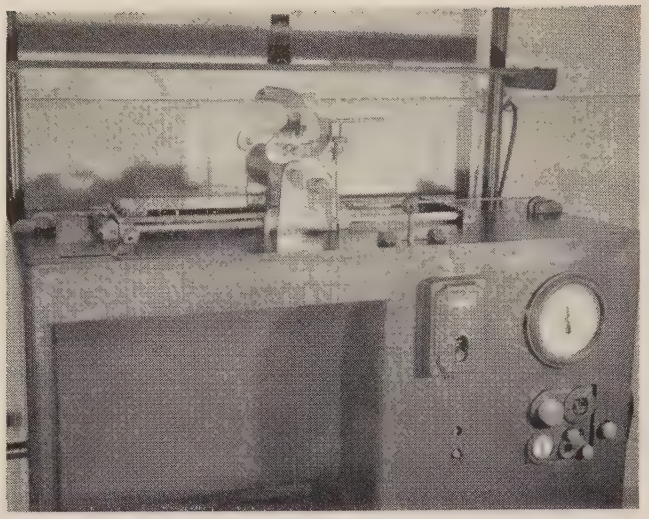

Fig. 1. Front view of rotary pick tester

individual particles or small groups of particles not being sufficiently well bound together. Peeling, where the coating is well bonded to itself but only loosely tied to the base sheet, is a separation of the coating from the base sheet. Rupture, or base sheet pick, occurs where the fiber base is too weak and is pulled apart by the action of the external forces. In order to intelligently analyze or to improve the bonding strength qualities of a sheet of paper, it is desirable to determine, not only the type of picking that occurs, but also a quantitative measure of the surface resistance to that type of picking.

Many of the tests used in the past for measuring surface bonding strengths were entirely qualitative, while others were at best only semiquantitative. The Institute of Paper Chemistry has published a series of reports (*1*) covering a comprehensive investigation of these various tests, as well as describing the principles of a new method designed to eliminate the shortcomings of the available tests. Using the Institute's work as a background, a series of investigations were undertaken which culminated in the design and construction of the rotary pick tester now used in the Kimberly-Clark laboratories.

When a cylinder to which a sample of paper has been attached is rolled over a surface carrying a thin film of some viscous fluid, the film is split at the leaving side of the nip and a portion of the fluid is transferred to the paper surface. Ordinary printing is a typical example of this type of transfer. If, however, the bonding strength of the paper is too low, the split will occur in the sample instead of in the fluid film, and picking results. The force applied to the paper surface depends among other things on (1) the viscosity of the fluid, (2) the thickness of the film, and (3) the speed of the cylinder.

DESCRIPTION OF INSTRUMENT

The present apparatus, a front view of which is shown in Fig. 1, is the result of an attempt to simulate, in part, the action that takes place in a printing nip. It consists basically of a stationary, resilient impression cylinder to which one or more test samples can be attached and a movable, nonresilient flat plate, together with means for applying a uniformly thin film of ink or other picking medium to the surface of the plate. Experience has indicated that the picking force is dependent on the angle and speed of separation of paper and plate. A test sample mounted on a flat surface would permit considerable variation in the angle of separation, unless it were firmly cemented to the plate surface. This tendency to pull away is much less pronounced when the sample is wrapped around a cylindrical surface.

A diagram illustrating the essential parts of the tester is shown in Fig. 2. The unit is completely motorized, using a $^1/_3$-hp., single-phase motor (1) with a built-in reduction gear. Operating at a shaft speed of 48 r.p.m., this motor provides power for operating the inking mechanism as well as for the actual test. A double-throw lever (2) engages either of two cams (3), one drawing the plate (7) to the right, simultaneously spreading on a thin film of ink, the other drawing it to the left during the actual testing operation. This is accomplished by means of a cable (9) fastened to the two ends of the plate and operating over a system of pulleys as indicated in the diagram. A metal dowel pin (10), riding in a carefully machined groove in the cams (3), will draw the cable (and plate) to the right or left depending upon which cam it engages.

In order to get a test on every sample, it is necessary to cover a fairly wide range of speeds. The most desirable arrangement appeared to be a cam which would give a speed proportional to the distance traveled, thus providing an open scale over the entire range of speeds. Such a cam was calculated from the equation for a logarithmic spiral,

$$\rho = e^{a\theta}$$

where ρ is the distance from the center of the shaft, θ is the angle traveled, a is a constant depending on the geometry of the instrument, and e is the base of the natural system of logarithms. The cam used in this tester provides a travel of 20 cm. with velocities ranging from zero at the start to a maximum of 60 cm. per sec. at the end. This is equal to a speed of 120 f.p.m. at the end of an 8–inch travel.

The impression cylinder consists of a 3.5-inch diameter rubber-covered roll (4). It is 6 inches long and has

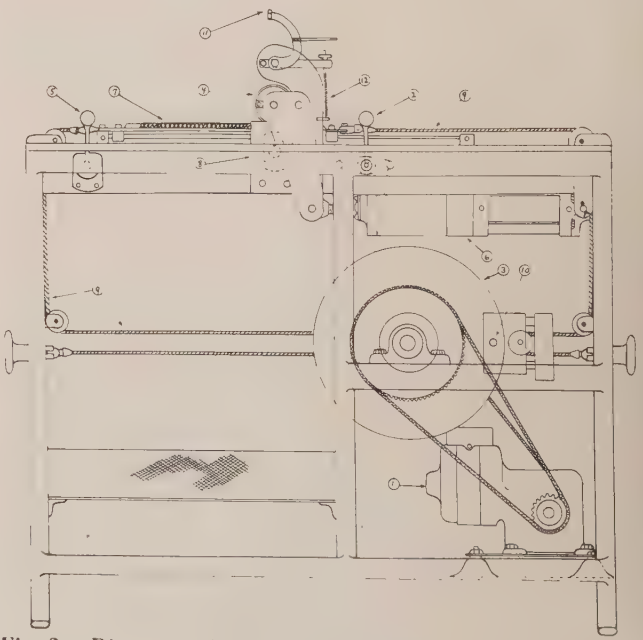

Fig. 2. Diagram of apparatus illustrating arrangement of working parts

a built-in gripper device for clamping the leading edge of the test sample. The roll can be thrown in and out of impression by means of a hand lever (5) operating on a 3-inch diameter air-draulic cylinder (6). Although normally operated at a pressure of about 140 pounds per linear inch, the pressure can be varied at will over a considerable range. In order to avoid deflections in the nip, a second roller (8) is mounted directly under the plate support and opposite the impression cylinder.

Since it became apparent early that there were serious disadvantages to using ordinary printing inks (largely because of their non-Newtonian character), the problem of making observations with a practically colorless fluid such as blown castor oil, was given serious consideration. In order to provide as much contrast as possible so that small particles of clay or fiber could be easily detected, the printing plate (7) was made out of a very smooth sheet of black Carrarra plate glass 12 inches long and 6 inches wide. Although single samples can be tested, we have found it more desirable to test five samples at a time. These samples are cut into 1-inch wide strips and fastened at one end to a 6-inch wide backing sheet with Scotch tape. In this way, five pick values can be obtained for every inking of the plate.

Although the test can be operated over a considerable range of film thicknesses, the force exerted on the paper surface by that film is a function of its thickness. It is, therefore, imperative that a smooth film or uniform, reproducible thickness be obtained.

Early in the course of this development it became apparent that the spreading of a thin film on the plate by means of a rubber roller produced neither a very uniform film nor an easily reproducible one. Much better results were obtained by making a pulldown using a smooth piece of quarter-inch welding rod (11) mounted securely in a pivoted support. Two thumb screws operating on a pair of coil springs (12) furnish means for controlling the pressure, and hence, the film thickness applied to the glass plate. A motor-operated cam is used to draw the plate along under the bar at a constant speed.

After experimenting with a range of film thicknesses, a standard of 0.00030 ± 0.00003 inch was set up for routine testing purposes. This value has been found to

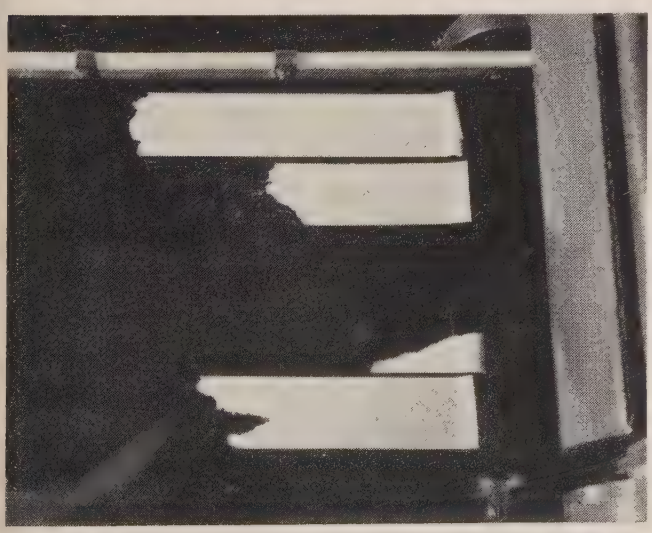

Fig. 3. Pick tests on five strips of coated paper

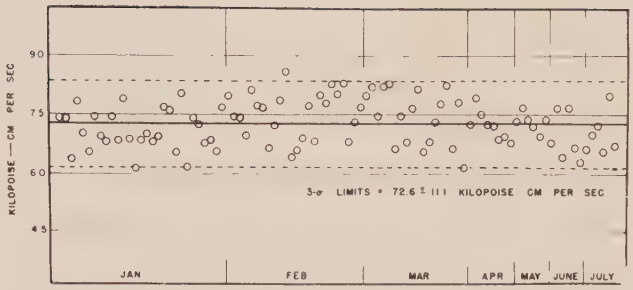

Fig. 4. Control chart for velocity-viscosity product. Sample size 5

be easily reproducible over a period of many months, requiring only an occasional minor adjustment in spring tension.

MEASUREMENT OF FILM THICKNESS

The actual film thickness can be determined by several different methods. For instance, knowing the density of the picking fluid and the weight per unit area of film, one can readily calculate the actual thickness. The weight can be determined by carefully scraping or wiping the film from a known area of the plate and weighing it on an analytical balance.

Another method that has yielded good results involves the clamping of a flat, transparent glass plate onto the inked plate, illuminating with monochromatic light and counting the interference fringes between the two plates. The top plate must, of course, have two points of contact, one directly to the bottom plate, the other to the top surface of the ink film. Since the difference in thickness between two successive dark bands or fringes is one-half wavelength of light, the thickness of the film is equal to $n\lambda/2$, where n is the number of fringes observed and λ is the wavelength of the incident light.

An entirely satisfactory and much more rapid means for determining film thickness is provided by the Interchemical Wet Film Thickness Gage. This instrument consists essentially of two concentric wheels supporting a carefully machined eccentric center wheel. By rolling the gage on the wet film until the eccentric wheel makes contact, the film thickness can be read directly to the nearest 0.0001 inch and estimated to the next decimal place. This gage is manufactured by the Henry A. Gardner Laboratory, Bethesda, Md.

TESTING PROCEDURE

The actual operation of the tester is relatively simple. The draw bar for spreading the fluid film is pulled down into contact with the glass plate, a bead of castor oil is placed on the plate ahead of the bar, and the inking cam engaged by means of the right-hand lever (2). The cam disengages automatically at the end of the travel. The draw bar is then raised off the plate and one end of the previously prepared test sample is fastened to the impression roll by means of a simple gripper device. The roller is thrown into impression with the left-hand lever (5) and the testing cam engaged with the right-hand lever (2). The velocity at which picking starts is read directly off a scale on the front side of the plate carriage. A measure of the picking force (in kilopoise cm./per sec.) is obtained by multiplying this scale reading by the viscosity of the oil at the testing temperature as indicated by the thermometer on the plate carriage. The various types of

Table I. Pick Values for Five Samples Shown in Fig. 3

Sample no. (from back to front)	Scale reading, cm.		Pick, kilopoise cm./sec.	
	Rupture	Initial pick	Rupture	Initial pick
1	7.0	6.8	37	36
2	12.3	8.9	64	46
3	20+	20+	110+	110+
4	15.8	6.7	82	35
5	9.8	9.8	51	51

pick can be readily distinguished and values assigned to each of them.

For best results, it is desirable to operate the tester under conditions of constant temperature and relative humidity. In the first place, the viscosity of the blown castor oil shows a strong dependence on temperature and there is some indication that the constancy of the velocity-viscosity product does not hold too well over wide ranges of viscosity. In the second place, some papers show a definite tendency toward lower pick resistance at high relative humidities. Elimination of these uncontrolled variables adds appreciably to the reliability of the test results.

Since the picking fluid is transparent, viscosity determinations can easily be made by means of the falling ball method. This consists of placing a steel ball of known diameter on the surface of the fluid and allowing it to descend, noting the time required for it to fall a a predetermined distance. The viscosity, in kilopoises, can then be calculated from these data. By making a series of such measurements at different temperatures, the viscosity-temperature relationship can be determined.

Although blown castor oil has produced generally satisfactory results, there would be some advantage in using a picking fluid having more stable characteristics. In the case of ordinary printing ink, an important disadvantage lies in the fact that its apparent viscosity decreases with increasing rate of shear. This not only makes it impossible to obtain an accurate measure of the force applied to the paper at any given speed, but also increases the required range of speeds in order to counteract the decrease in apparent viscosity.

TEST RESULTS

A typical example of the type of results obtained on the rotary pick tester is illustrated in Fig. 3. This is a reproduction of the plate surface taken after running through a test sample containing 1-inch strips of five different coated book papers. The results of this test are shown in Table I, which lists both rupture and initial pick values. The latter is the point at which the first sign of surface breakdown is observed. Our experience indicates that all of these papers are strong enough for most letterpress purposes, but that samples 1 and 5 are definitely too weak for some offset requirements. Samples 2 and 4 have appreciably higher rupture values, but show a considerable amount of coating pick. Papers of this type may cause a gradual build-up on an offset blanket, resulting in poorer quality and lower plate life. Finally, sample 3, which shows no signs of failure throughout the entire range of speeds, should satisfy the most exacting requirements of offset printing.

Table II. Rupture Values (in Kilopoise Cm./Sec.) for Six Samples of Coated Book Paper

Mill	Grade	Machine direction		Cross direction	
		Wire	Felt	Wire	Felt
A	LP	110+	63	79	50
B	LP	110+	96	58	76
C	LP	110+	56	69	33
A	Offset	110+	70	79	66
B	Offset	110+	110+	93	98
D	Offset	90	87	65	60

Table III. Effect of Nip Pressure on Rupture Values

Air pressure, p.s.i.	Nip pressure, lb./lin. in.	Rupture, kilopoise cm./sec.
5	23	73
10	47	61
15	70	60
20	94	54
30	141	57
40	188	56

The data in Table II show rupture values obtained on samples from six grades of coated book papers, all acceptable to the printing trade as generally satisfactory paper. In most cases, the felt side is weaker than the wire side, and the cross direction samples are in all cases significantly weaker than those tested in the machine direction. This is of particular interest in the case of offset papers, where, for register purposes, the paper is almost invariably specified grain long, and run through the press in the cross-machine direction. Coating pick, which causes fill-up in letterpress halftone plates and build-up on offset blankets, follows a pattern very similar to the rupture data given in the table. It is evident that grain direction differences are an important factor in any attempt to correlate test data with commercial experience.

Table III lists a typical set of data showing the effect of nip pressure on rupture values for a sample of coated offset paper. Although, in general, there is a trend toward higher values at the lower pressures, the difference becomes highly significant only at extremely low pressures.

Figure 4 shows a control chart for velocity-viscosity product for samples taken from a single randomized population of a no. 2 coated offset paper. The data for this chart were taken during the first 7 months of 1950 and indicate no significant shift over this period of time. Although this particular population shows a somewhat greater variability than most papers, the spread in values, nevertheless, points out the danger of drawing conclusions from a single test on a very small area of the sheet.

The original testing unit was constructed in 1947 by the Kimberly-Clark Engineering Department for use in the Research and Development Laboratories. Since then, the program has been expanded to include mill quality control testing.

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ASSOCIATION NEWS AND EVENTS

Attendance at International Symposium

The following individuals attended the International Pulp and Paper Symposium held at Appleton, Wis., on Sept. 17–21, 1951. This symposium was sponsored by The Institute of Paper Chemistry and the Technical Association of the Pulp and Paper Industry.

The papers presented and the discussions, together with the papers presented in the Tropical Woods Symposium of the U.N. Food and Agricultural Organization, will be published in *Tappi* as soon as they are released and have been edited.

The following list is printed because it gives the addresses of nearly every major institution doing fundamental research work in the fields of cellulose and lignin:

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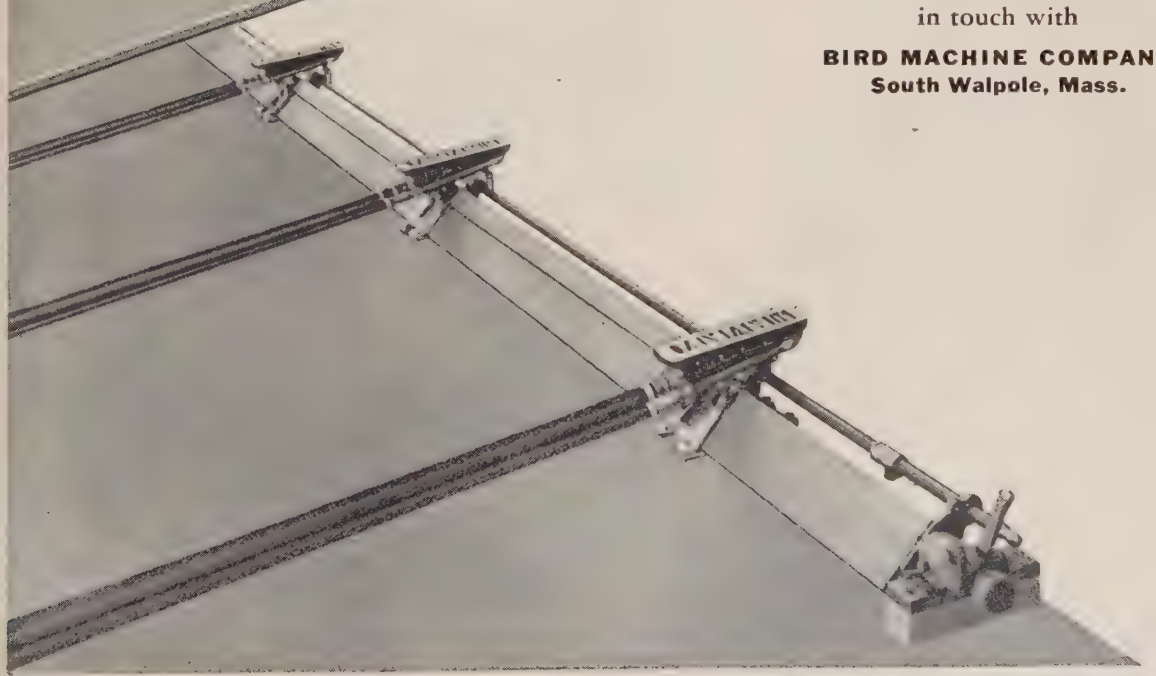

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Alkaline Pulping Conference

The 5th Alkaline Pulping Conference sponsored by the Technical Association of the Pulp and Paper Industry was held at the John Marshall Hotel, Richmond, Va., Sept. 26–28, 1951. The Chairman of the TAPPI Alkaline Pulping Committee and chairman of the opening session was Henry Vranian of the Chesapeake Corp. of Virginia, West Point, Va.

Henry Vranian (Chesapeake Corp. of Va.), Chairman: This is the opening of the Fifth Alkaline Pulping Conference. We think we have a good program and in order that all speakers have an equal opportunity, each will be limited to 28 minutes for presentation and discussion. We suggest that the speakers allow about half their allotted time for the discussion. It will be appreciated if you will give your name and company when speaking from the floor. The floor microphone may be used.

Thank you, gentlemen, and now we will proceed with the first paper, "The Cellulosic Raw Materials Situation," by James W. Cruickshank of the U. S. Forest Service.

The production of wood pulp in the United States has increased over 100% in the last decade, and pulp mill expansion proposed during 1951 will greatly increase the capacity of the industry. The tree species preferred for pulping are declining in volume in all major regions of the United States. Sources of additional cellulose include logging and sawmill waste and little-used species in the Pacific Northwest, pulping species in the Rocky Mountain, aspen in the Lake States, and cull hardwoods, scrub oak, logging and manufacturing waste in the South. Increasing the timber yields through better forestry offers the best long-term approach to an abundant supply of cellulose.

Chairman Vranian: Thank you very much, Mr. Cruickshank, for a very informative paper. Since we have run a little over our time, we will proceed with the next paper,

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"Methods of Checking Wood Quality and Chip," by M. Klein and J. M. Ralson of the Union Bag & Paper Corp.

Mr. Ralson then presented the paper.

Wood quality counts at Union Bag & Paper Corp. are made independently of wood scaling. The quality counts are made to determine trends in the quality of new receipts and the effect of wood quality on operations. Approximately 1% of the new receipts are inspected. Each bolt is classified according to definitions set up for each of the following types of undesirable wood: old wood, crooked and limby wood, small wood, and catface wood. Wood quality counts are difficult to correlate with pulp yields because of a number of other variables affecting yields. A sample graphical presentation of the quality counts for the last four years is included.

Chip size distributions are determined on routine chip samples taken each shift at the chip bins. The Williams standard chip screen is used for these determinations in place of the regular TAPPI Standard Method. Because of numerous other variables involved, it is difficult to correlate chip size with pulp yields. However, these data are quite useful in aiding the operating department to control wood room operations. Data from special chipper tests are presented.

K. D. Running (Halifax Paper Co.): When you went up to a 40° angle on your chipper knives, did you not find a decrease in cords chipped per hour?

Mr. Ralson: Yes, but we have plenty of capacity in our chipping operations.

Mr. Running: From the tables presented, I note that you have a considerable quantity of chips of approximately 1 inch. Do you have forced circulation on your digesters?

Mr. Ralson: No. Direct steaming.

Chairman Vranian: If there are no further questions I would like to thank Mr. Ralson and introduce the next speaker, Vance P. Edwardes, Consultant, Corinth, N. Y., who will talk to us this morning on "Chipper Operation."

Chipper operation and maintenance are very important factors in the production of sawdust and chip uniformity.

On 4-knife chippers:

Sawdust varies directly with the speed.

Percentage of chips of the desired size increases with decreasing speed.

Power per cord varies directly with the speed.

Paper strength increases with decreased speed.

On four or multiple knife chippers:

Knife sharpness has a marked effect on sawdust and power.

Chipper condition has an important bearing on sawdust and chip quality.

Using chipper to capacity reduces sawdust and increases chip uniformity.

Knives should be changed rather than filed.

The bed plate should be kept sharp and in close adjustment to the knives.

P. B. Borlew (Container Corp. of America, Fernandina, Fla.): I was wondering if the speaker would elaborate a little on the reduction in speed and increase in bursting strength.

Mr. Edwardes: Most of this work was done on four-knife chippers and a sulphite pulp, but one set of tests indicated that a reduction in speed from 300 to 200 produced a pulp of 87 burst compared to the former 82.

M. B. Pineo (Brunswick Pulp & Paper Co.): We ran some sawdust determinations together with other investigations and found that the width of the chip affected the pulp quality as much as or more than chip length.

Mr. Edwardes: There is naturally a great deal of difficulty in getting a true chip classification, but one way of getting a true measure of chip size is by putting the chips through the screen by hand.

Mr. Pineo: We have physically measured the length.

Mr. Edwardes: In all this type of study, there are many variables such as wood age, season of the year, climate, temperature, etc. It takes a long time to average out the results of such tests.

Mr. Running: You mentioned that there was little effect on sawdust in going from 37 to 41½%, what were the observed differences in cords chipped per hour?

Mr. Edwardes: None.

P. Gilmont (Crossett Lumber Co.): How was the pulp from hand chips made?

Mr. Edwardes: Disks were cut from the logs with a saw, then chips were cut with a knife, then cooked separately in a basket side by side with control basket in the one digester.

W. M. Ebersole (Macon Kraft Corp.): Do you not think that the condition of the surface and the position of the throat are of as great importance as the condition of the bed knife? We believe it should be hard surfaced and trued up with the knives similar to the way the bed knife is set.

Mr. Edwardes: I have felt for a long time that the condition of the throat is very important, but do not have definite information on this.

Floor: Further to the question of hand-cut chips, one gentleman has shown that when drying pulp made from hand-cut chips there is not the loss in strength in comparison to the loss in strength from the drying of pulp from commercially prepared chips.

G. O. Lee (Union Bag & Paper Corp.): Do I understand 1500 to 2000 cords before changing the bed knife? Do you have any information as to what these bed knives were made from?

Mr. Edwardes: Stellite tipped. A steel tip would not give near such a cordage before the bed knives needed changing.

Chairman Vranian: I have some questions that I would like to ask Mr. Edwardes, but since we have a full program I will ask them tonight. Thank you, Mr. Edwardes.

The next paper is entitled "Effect of Chipping Knife on Wood Conservation," by Harold Wood, Jr., of the Heppenstall Co., Pittsburgh, Pa., Mr. Wood.

The solid alloy steel chipper knife was first developed by the Heppenstall Co. between 1932 and 1934. Since that time, many modifications have been made in steel analysis and design, but it still requires complete quality control over the normal operations of melting, forging, annealing, machining, heat treatment, grinding, and inspection to produce chipper knives.

Since a chipper knife is a precision cutting tool it should be treated as such to give it the best opportunity to perform satisfactorily. Grinding equipment and technique must be closely watched. The grinding of high-alloy steels requires modern grinding equipment and close supervision to prevent damaging the pieces being ground.

Other factors, however, influence knife performance. These include correct bevel, proper chipper maintenance, and an intelligent approach as to when the knives should be changed. All these factors affect knife costs, and they should be considered by the individual mills when they figure their over-all cost of producing chemical pulp.

W. P. Lawrence (Champion Paper & Fibre Co.): What type of grinding wheel do you recommend for knives with 3 to 5% vanadium content?

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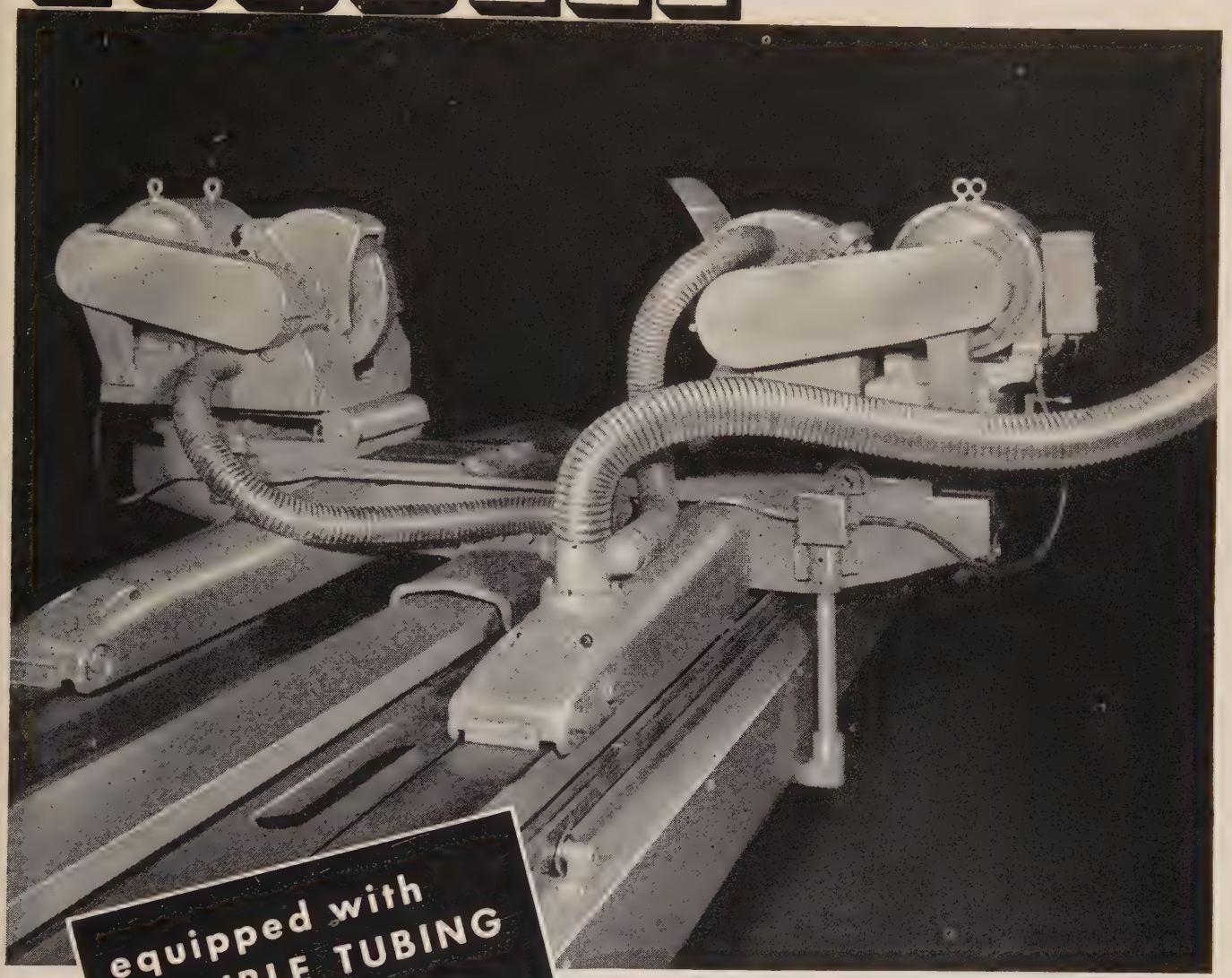

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Mr. Wood: Use the coarsest and softest wheel, say a 44. Then if the knives are not burned, go to a finer and a little harder wheel.

Mr. Gilmont: Mr. Edwardes mentioned that the bed knife should be stellite or carballoy tipped. Would it be advantageous to use carballoy or stellite inserts in the knives?

Mr. Wood: No! The metal is too hard and brittle. We have tried this and have been able to chip one log before the metal has broken loose. The thinner the application the better the bond. In general, we consider this too hard and not suitable unless in extra thin thickness, less than $^1/_{16}$ inch.

Chairman Vranian: Thank you, Mr Wood. We will now proceed to the next paper, "Usable Wastes in the Woods," by J. J. Armstrong of Union Bag & Paper Corp. Mr. Armstrong is sick and the paper will be read by Professor A. E. Wackerman of the Forestry Department of Duke University, Durham, N. C.

Wood Waste Available for Pulping

J. J. Armstrong

Our country is generally recognized as being a land of plenty because of the extensive natural assets we have in soil, minerals, oil, timber, and many other resources. We not only have these vast natural resources, but we have the "know-how" for getting them into commercial production and making them beneficial to the people of our own country as well as the rest of the world. We know how to use our assets well, but perhaps not too wisely, because we are also known as a wasteful nation. In the past much of this waste occurred because of economic pressures that made it impossible to utilize low-grade oil, minerals, soils, and timber. Waste of wood and other substances is necessary when there is no use for it. In a sense, under such conditions the nonuse of cast-off wood and other substances not needed at the time, is not a waste because to utilize it could only be at a loss and this is an economic waste in itself.

We all know that we have been extremely wasteful in dealing with our forests and in utilizing the trees that came with the country, let alone those that we have grown ourselves. In recent years, we have eliminated many of the former wasteful practices in harvesting and using our forests because of the greatly expanding need for wood and the many various ways in which wood can now be used, whereas formerly it had but limited applications.

For years our forests burned and no particular attention was given to controlling such fires. Not only was merchantable timber destroyed but also, and equally as important, the reproduction or the young timber was constantly killed by repeated fires that left the land barren and unproductive for many years. Now we have become fire conscious and forest fires are fought furiously wherever they occur and whenever they occur, not only by state and federal agencies but also by private companies and individuals owning forest land. Also we are much more careful how we harvest and cut timber and in using wood by-products instead of discarding them.

In spite of all the progress we have made in fighting fires and in utilizing our timber to best advantage, there is still a great deal of actual waste of usable wood in many of our forest industries. There is more wood wasted in lumbering perhaps than in any other industry because, first of all, the lumber industry uses more wood than all the rest put together and, in addition, the lumber industry can only use wood in the whole piece and it has to be of standardized sizes. Therefore, in sawing logs into lumber those portions that do not meet the specifications or are too small or too short, must be discarded or thrown away.

J. J. Armstrong, General Manager, Woodlands Division, Union Bag & Paper Corp., Savannah, Ga.

Because most of the waste occurs in logging and in lumber manufacturing, I am limiting my comments on waste utilization to opportunities for using the waste products of the lumber industry. Much of the waste in lumbering is in a form that is not very suitable for use, such as sawdust and shavings. These products can be, and are, to a limited extent used for pressed-board and similar commodities but such an outlet takes only a very limited amount of the total waste in this form.

A great deal of lumber manufacturing waste could be used for pulp if it could be concentrated and shipped economically to pulp mills because it is of a size suitable for chipping. This waste occurs both in the woods and at the mills. In the woods, it is in the form of tops and undersized stunted trees that are left and in the mills it is in the form of slabs and cutoffs from boards and timbers not suitable for lumber but composed of solid wood substance that would be excellent for pulping.

Studies made by our research forester a few years ago showed that pine sawtimber trees ranging in diameter from 12 to 22 inches at breast height and standing in the usual density on the land, contain enough pulpwood in the tops below normal log size to justify us salvaging them for this purpose. We found that there was about $^1/_{10}$ of a cord per tree in the tops below sawlog size which averaged about 9 inches at the small end. I know, as you do, that many mills cut smaller logs than this but when they do, there is much more chippable waste at the sawmill in sawing them into lumber than there is when larger logs are cut. Expressed another way this study showed that about $^4/_{10}$ of a cord was left in tops per thousand feet of lumber sawed by sawmills. Looking at it still another way, for every 2500 feet of lumber produced at sawmills approximately 1 cord of pulpwood was left in the woods in the form of tops not suited for sawing.

A recent study by the Southern Forest Experiment Station made at various kinds and types of sawmills throughout the south shows that the amount of chippable waste produced at pine sawmills cutting lumber from logs ranging from 6 to 9 inches in diameter amounts to about $^3/_4$ of a cord per thousand feet of lumber sawn. This waste does not include sawdust or other wood discarded that is too small to be usable for pulping. It refers strictly to chippable wood waste, principally in the form of slabs and cutoffs. This same study also showed, for the average run of logs, that approximately $^1/_2$ a cord of wood is wasted in slabs and cutoffs for every thousand feet of lumber sawn.

With an annual average production of close to 10 billion feet of southern pine lumber, this means that sawmills in the south discard, or use only for fuel, fully 5,000,000 cords of chippable wood each year. With about $^4/_{10}$ of a cord per thousand feet of lumber sawn occurring as waste in tops, plus the $^1/_2$ cord of wood wasted in slabs and similar discarded portions of logs at the mills, the total volume of wood wasted in lumber manufacturing in the south that could be available for pulping if a severe wood shortage should occur, amounts to 9,000,000 cords per year or well over half of the total used each year by the pulp and paper industry.

Some of this by-product wood from the lumber industry is used, but it is hard to tell how much. Nevertheless, it is obvious to anyone who looks at or is familiar with logging and milling as it is conducted in the south, that by far the most of it is wasted or used only for a very low-grade purpose such as fuel.

Small mills cut over 70% of the pine lumber produced in the south and they are mostly now diesel powered so the waste produced at these small mills is not even used for fuel. If it is burned, it is burned only to get rid of it. Small mill lumber is generally hauled rough and green to concentration yards where it is dried and then planed and finished to size before shipping. At these concentration yards and planing mills the sawdust and shavings from dry lumber are used for

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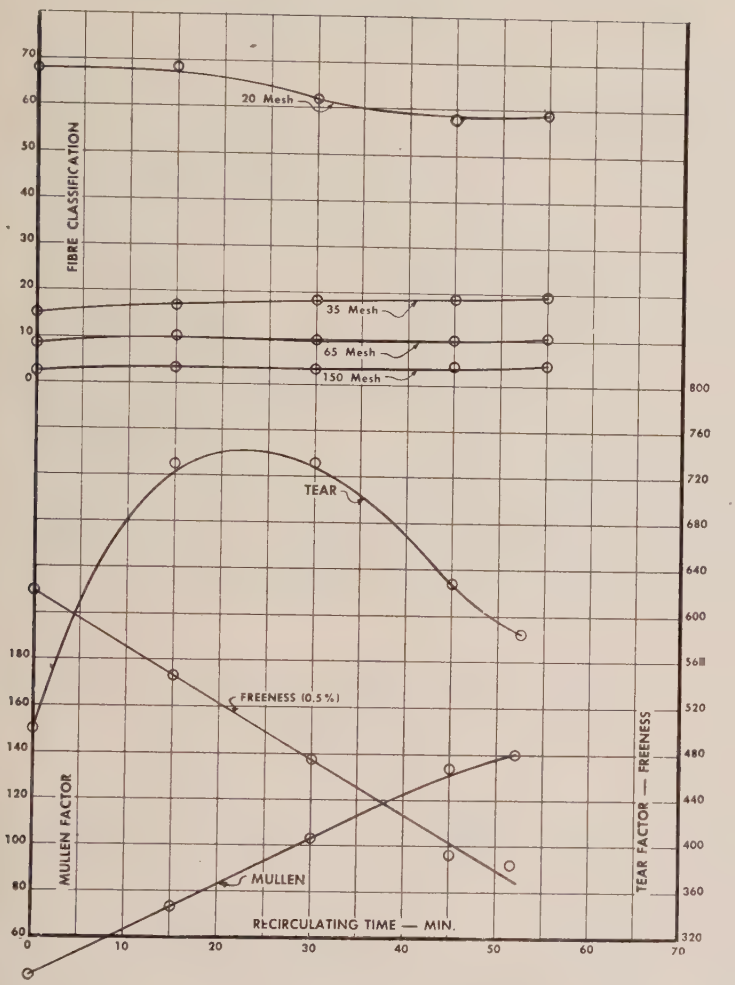

"BLEACHED SOUTHERN KRAFT PULP"
DATA FROM MILL OPERATION—NOT LABORATORY UNIT

NO. 2 HERMANN CLAFLIN REFINER
175 H.P.—400 R.P.M.

RATE

8000# Per hour. 3½% consistency. 15 minutes required to pass 2000#

PROCEDURE

Stock pumped from chest No. 1 to Claflin to chest No. 2 then from chest No. 2 to Claflin to chest No. 1.

RATE OF 2000# REQUIRING 15′

	Freeness	Mullen	Tear
Before	620	...	500
1–Pass	550	75	720
2–Pass	480	100	720
3–Pass	390	135	630

(FREENESS: CANADIAN GREEN)

NOTE:

It is conclusive proof that with Fibre Classification checked with Freeness Mullen and Tear that the Claflin developes Mullen strength with a very minimum of cutting making it possible to maintain a high Tear and develop maximum strengths at higher Freeness.

Information also available on unbleached kraft pulps and also sulphite pulps.

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fuel, principally to furnish steam for kiln drying. This waste is in the form of sawdust and very thin slices of wood from the planing machines so it is not suitable for pulping and is not included in the figures which I have given you. Only large stationary or permanent mills use green sawmill waste for fuel and all of this ordinarily is not needed. In fact, it is doubtful whether it would be combustible enough for steam-producing purposes if it were not mixed with the dry material from the planing mill.

Also some of the top wood from pine sawlog operations is used for pulpwood but not much considering the total volume available. Just how much again there is no way to sell but we do know that there is a tremendous waste from cutting sawlogs and leaving the tree tops to rot in the forest.

In common with most southern pulpwood paper companies, we have considerable amounts of pine sawtimber to sell from our forest lands. It consists of seed trees that have served their purpose and timber that has matured faster than we needed it for pulpwood. In making pine sawtimber sales, we always require that the tops be cut for pulpwood either by the sawtimber purchaser or by a regular pulpwood producer who follows the sawlogging operation and cuts pulpwood from the tops and from small trees not suitable for sawtimber or not worth keeping for growth. Otherwise, we do not sell the sawtimber. We have found no practical way as yet to use the slabs for pulping.

There are no particular difficulties in arranging to have our sawlog tops cut for pulpwood. If there is no other standing timber to go with the tops, a lower stumpage price than would be paid for clean standing timber may be necessary. Any fair price, however, is better than nothing and letting the wood spoil by rotting on the ground. We would rather use the whole tree for pulpwood even if it is of sawtimber size than to permit a portion of it to be wasted through nonuse.

Using slab wood and other sawmill waste, however, is much more difficult. The problem with slabs is the bark which must be removed before the slabs can be chipped. Slabs do not bark in drums like round wood as they bend and break and clog the drums and cause endless delays and excessive costs. Also, hand barking of slabs is too costly. But these are ways of barking logs mechanically that are not too expensive. So far they are only used at large permanent mills but it is not improbable that equally suitable methods will be perfected for use at portable mills if pulp mills were to encourage the use of sawmill slab wood for pulpwood.

The pulp industry gives a great deal of attention to present and future wood supplies. Generally this involves developing new round wood production and growing timber on industry-owned land, both of which are essential. However, we in the pulp industry could well look to ways of using sawmill and sawlog harvesting waste to supplement our round wood supplies. It is not entirely sensible to go to the trouble of growing pulpwood and at the same time not use wood equally as suitable that is discarded by a sister industry located in our back yards. We have not given this source of possible wood supply serious enough consideration, I feel. We should cooperate closely with the lumber industry. Not only with those mills that cut our timber but with mills cutting their own timber or timber that they purchase from individuals. Some attention on our part to this opportunity and some study by ourselves in developing ways and means of getting the bark from slabs would, I feel, be a very worth-while and productive activity for all of us.

Our expanding industry needs wood and needs more and more wood to keep our mills running and any wood whether it is round wood from our own lands or round wood from open market purchases or whether it is slab wood or cut-off wood from the sawmills, or top wood from sawlog operations makes no difference in the final analysis, as our industry is one that can take any suitable solid wood and chip it, pulp it, and process it to make the finest product the paper industry in this country knows.

CHAIRMAN VRANIAN: Since time is running short, we will have to forego discussion for the time being on this excellent paper and the following one by N. P. Wardwell of Carthage Machine Co., Carthage, N. Y., "Wood Losses in Chipper Operation."

Variables influencing waste in chipper are speed, condition of knives, angle of knives, condition of wood, wood ends, blowing, rough surfaces, and knife adjustment.

CHAIRMAN VRANIAN: Thank you, Mr. Wardwell. I also wish to again thank all speakers for their excellent papers and cooperation in allowing the program to move on schedule. Particular credit is due to Bob Fuller who performed the task of assembling this nice program. Also, much credit is due the local committee of Al Yundt, George Tennant, and M. G. Selden. Without help from men like these this meeting would not have been possible. We will now adjourn for luncheon which is due to start promptly at 12:30 in the Roof Garden.

Wednesday Luncheon

R. G. Macdonald, Secretary of TAPPI, acted as Toastmaster and introduced the members of the Alkaline Pulping Committee seated at the head table as well as the Hon. T. Nelson Parker, Mayor of Richmond, who welcomed the group attending the conference.

Wednesday Afternoon

CHAIRMAN VRANIAN: We are now ready to start the afternoon session—the first paper being "Suspension Burning of Bark Refuse," by Robert Ellwanger of the Chesapeake Corp. of Virginia.

Previously classified as a waste product resulting from the operation of paper mills, bark refuse now assumes a prominent place as a low-cost substitute fuel for steam and power generation.

A short history of wood burning from piles to the development of a boiler, furnace, and auxiliaries designed primarily for suspension burning, utilizing flash drying, and extreme furnace turbulence is discussed.

The problem of efficiently burning this material is resolved in this presentation to two main topics—first, fuel handling and preparation and second, fuel burning and the combustion system including an analysis of fly-ash reinjection.

Figures are presented on predicted and actual performance together with efficiencies and carbon loss.

Mr. Ellwanger then introduced Carl E. Miller of Combustion Engineering-Superheater, Inc., who provided a running commentary during the showing of the color film "Bark Furnace in Operation" by Otto De Lorenze. Before the showing of the film, Mr. Miller stressed that all the films had been underexposed, of necessity, due to the intense heat. The temperature is 2400 to 2600° within the furnace. Some of the photos were taken at 64 frames per second, and are now shown at 16 frames per second. Thus the turbulence is four times as great as seen on the screen. Another interesting point with this new principle of firing was that when looking from the top of the floor downward we are looking through 23 feet of roaring fire. Mr. Miller then presented the film.

MR. KUHN (Fairfield Co.): Do you consider it necessary to use bark hogs before the bark is fed into the top of the furnace?

MR. ELLWANGER: Hogging is necessary in our opinion. Coal is screened and graded for stoker use. Coal is pulverized for use on the powdered coal furnace. Bunker C oil is heated and treated with solvents to drop out sludge and undesirable hydrocarbons. Bark is removed from pulpwood and pulpwood itself is cut into chips in preparation for digestion. If all the above are prepared, then by deductive reasoning it seems logical to conclude that bark should be hogged and properly prepared for correct combustion by this suspension-burning principle.

St. Helens Pulp and Paper Company selects a C-E Recovery Unit

The $5,000,000 expansion and modernization program of the St. Helens Pulp & Paper Company at St. Helens, Oregon is now shaping up rapidly.

A feature of the new extension will be a C-E Recovery Unit which is now in process of engineering and fabrication. This unit will burn 875,000 pounds of dry, black liquor solids per 24 hours. Its design pressure is 675 psi but the initial operating pressure will be 250 psi. Later the operating pressure will be raised to 600 psi. Total steam temperature is 750 F.

Based on a sound, basic design, enhanced over the years by carefully developed improvements, the C-E Recovery Unit now enjoys a widespread, service-proved reputation for efficiency, reliability and operating economy. Naturally, more and more pulp and paper companies are selecting Combustion equipment both for new installations and for expansion and modernization of existing facilities. B-521

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PRODUCTS FOR THE PAPER INDUSTRY INCLUDE RECOVERY UNITS, STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; ALSO PRESSURE VESSELS

Mr. Elderkin (Crossett Lumber Co.): How much steam do you produce per cord of wood?

Mr. Ellwanger: 1750 pounds of steam per cord of pulpwood. We have gone as high as 2000 pounds for short terms, but the average over 6 to 8 months when we are sure of our pulpwood usage, has come out to 1750 pounds per cord of wood. Further, our records show 3.85 pounds of steam per pound of bark.

Chairman Vranian: We will all have an opportunity to see this unit in operation tomorrow and ask any further questions. Thank you, Mr. Ellwanger.

We will now proceed to our next paper entitled "Survey of Chipping Operations," by R. H. Stevens of National Container Corp., Jacksonville, Fla.

Mr. Stevens reported on the results of a questionnaire that had previously been forwarded to all the alkaline pulping mills in the country. Responses were received from over 60% of the industry. Data were obtained on the chippers; the knives, the bevels used, and hours between grindings; chipper speed; drives, among others.

Analysis of the data fails to reveal anything to challenge the engineer or the operator of chip preparation equipment unless it be the wide disparity in connected horsepower per cord per hour.

There is a fairly wide variation in digester yields even from similar woods cooked to approximately equal degrees of pulp hardness. Nothing in the replies gives any direct clue to the cause of this.

A. P. Yundt (Camp Manufacturing Co., Inc.): I should like to congratulate Mr. Stevens for this fine presentation, but would also wish to make the recommendation that the data as presented might be re-expressed. For instance, the number of cuts before resharpening of the knives might have more meaning than the number of cords cut before resharpening. Also, you might recalculate some of these data based on peripheral speed, rather than simply on chipper diameter.

D. J. MacLaurin (Institute of Paper Chemistry): I would also like to congratulate Mr. Stevens. I found this very interesting and also would like permission to add a few comments. First, the rate of feed to all chippers varies so greatly that the power consumed per cord will naturally vary immensely and thus there will be but very little correlation. Also, in calculating the dry yields in pounds per cubic foot I would suggest that you go further and express the data in pounds per cubic foot of digester space per day. This should have more meaning.

Mr. Stevens: In the questionnaire that was sent out, I should have asked about the number of cooks per day which would have permitted such calculations as you have suggested.

Chairman Vranian: Thank you, Mr. Stevens and gentlemen. The next paper is entitled "Coating Ingredients from Tall Oil," by C. R. Outterson and M. G. Selden of Albemarle Paper Mfg. Co., and J. W. Eldridge of the University of Virginia, which will be read by Mr. Selden.

The literature states that coatings containing tall oil will dry, but the rate and type of drying is considered to be impractical from the viewpoint of modern manufacture.

The value of a drying oil consists in its ability to form a satisfactory film over surfaces to which it is applied in the form of a liquid, and to act as a binder for pigments.

Both raw linseed and tung oils have been used as vehicles for paint, varnish, and allied products but are now being used as raw materials in the preparation of better vehicles. Also, the properties of all of the drying oils are being modified and improved by adding resins and heating. Thus, paint vehicles can be designed to emphasize any desired property and this provides the opportunity to develop tall oil into products having broad markets.

A tall oil product that compares favorably, insofar as its oil length permits, with the modern vehicles made from the established drying oils including linseed and tung oils is described and the chemistry involved in the preparation thereof is outlined. The tall oil is converted into a varnish consisting of a synthetic resin having optimum properties in a neutral oil.

The meaning and importance of oil length is explained.

Chairman Vranian: If there is no discussion, I would like to announce that at the conclusion of the next paper we will have the film on chipper operation by Mr. Wardwell. The next paper is titled "Flash Drying of Lime Kiln Feed," by H. Vranian of the Chesapeake Corp. of Virginia and Robert D. Nickerson of Combustion-Superheater, Inc., New York, N. Y. The paper will be presented by Mr. Nickerson.

Flash drying of calcium carbonate lime kiln sludge is used for the first time to supplement the capacity of an existing rotary kiln in a pulp mill.

The carbonate product is delivered from the drier to the kiln at a controlled moisture content. Most of the former drying zone in the kiln is now available for calcining, resulting in increased lime-burning capacity.

The heat for the drier is drawn from the plenum chamber of the lime kiln stack. Under the present conditions the drier does not use all the available heat and some is by-passed to the stack.

As a result of drying, the lime-burning capacity has increased by 40% . . . fuel consumption reduced by 38%, and make-up lime reduced by 37%.

Use of a secondary dust collector is considered advisable and should reduce the make-up lime further.

Roderick O'Donoghue (Consultant): I would like to ask two questions. First, does the lime kiln still ring up and second, is the feed to kiln in powder form or is it in small balls?

Mr. Nickerson: The kiln still forms rings. The lime is in small balls, about the same type of material as would exit from a 30-foot chain section.

Mr. Kuhe: How many B.t.u. are lost per ton?

Mr. Nickerson: About 10,000,000 B.t.u.

Mr. Kuhe: Why do you need to waste this?

Mr. Nickerson: The answer is that we do not need to waste this 10,000,000 but that is the way it is operated at the moment.

Mr. MacLaurin: How much power is involved?

Mr. Nickerson: 125 kw. for the flash drier alone. It is operating at 75% of its designed capacity.

J. M. Ferguson (Howard Smith Paper Co. Ltd.): What percentage is recycled back through the flash drier?

Mr. Nickerson: About 4 or 5 to 1.

George H. Whiteside (Container Corp. of America): The 10% moisture in the lime fed to kiln, was this determined by experiment?

Mr. Nickerson: We have no preference. We have run from 8 to 15% of moisture to the kiln. If the operator cannot control this by opening and closing the slide gate then he makes adjustments to the hot damper.

F. L. Brinkley (North Carolina Pulp): What happened to the chain section?

Mr. Nickerson: We never had one. If a mill did have a chain section, it would have to be removed.

Mr. Gilmont: What is the savings in dollars and cents per ton of pulp?

Mr. Nickerson: They are now using about 800 gallons of fuel oil less per day than they were in 1950.

Mr. Ferguson: Is there any special reason for using the recycle system?

Mr. Nickerson: No! Except you must get the water out of the lime mud and this seemed the most economical installation. Power is wasted, but this is true of all industrial equipment and processes.

Mr. Ferguson: Does the cyclone ever plug?

Mr. Nickerson: Yes, it would if the temperature falls to 130° but this has not happened.

Mr. Kuhe: Will this equipment add to your capacity?

Mr. Nickerson: Yes, this unit will release the chain section of a kiln, which will add an additional 30 or 40 feet for calcining.

Chairman Vranian: Thank you, Mr. Nickerson. We will now have the film on chipper operation by Mr. Wardwell. At the conclusion of this showing, we will adjourn for the day. Thank you, gentlemen.

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Cooking Symposium (Thursday, Sept. 27, 1951)

R. R. Fuller (Gulf States Paper Co.) Chairman: In opening the meeting today I want to call your attention to the meeting yesterday and the general trend of the meeting. The pulpmaker is between a rock and a hard place in the industry. Forestry is insisting on using toothpicks, tree tops, and wood waste. Management is insisting on more yield per cord. Our problem is to achieve both these ends, and it is with this background we approach today's discussion of cooking—devoted to greater yield of acceptable pulp per cord furnished.

There will be no discussion on the various papers until the conclusion of the panel discussion this afternoon.

The first paper "Repulping Kraft Rejects," by K. G. Chesley, P. L. Gilmont, and J. E. Parnell of the Crossett Lumber Co., Crossett, Ark., was given by Mr. Gilmont.

The material separated from acceptable pulp by knotters and screens represents a large volume of waste material suitable for recovery. These rejects may be refined mechanically for a coarse grade of pulp, or they may be recooked for paper grade pulp.

Experimental studies on recooking rejects show a high yield of pulp from both knotter and screen rejects. The conditions required for satisfactory pulping on recooking are similar to those required for pulping chips; therefore, rejects may be cooked in mixtures with chips and still retain the advantage of high yield.

Recooked rejects do produce a pulp with a weaker fiber than pulp from fresh wood. The loss in bursting strength is more pronounced than in tearing strength. However, the reduction in strength is not great enough to materially affect the paper produced, inasmuch as these rejects represent a relatively small percentage of the digest charge. The specific volume of rejects is considerably greater than that of fresh wood.

In mill scale recooking of rejects with fresh chips, an improvement in over-all yield from the wood was obtained without appreciable loss in digester capacity or strength of pulp. While cooking of rejects requires more attention than cooking of chips due to impeded circulation and gas relief, the improved yield and reduction of pollution more than compensate for this disadvantage.

The second paper of the morning's session was given by Joseph F. Keyes of the North Carolina Pulp Co., Plymouth, N. C.

Controls, Circulation, and Indirect Heaters on Digesters

Joseph F. Keyes

In 1937, North Carolina Pulp Co. installed five 3300-cubic foot digesters with indirect heaters and circulating pumps. In 1940, two more digesters were added with indirect heaters and circulating pumps. In 1945, four more digesters were added with "improved" circulating pumps and indirect heaters.

In 1947–48, considerable work was done experimenting with time cycle steaming of digesters and automatic gas-off. This was the third time that experimental work was done in conjunction with instrument manufacturers on time cycle and gas-off controls. The previous work had not been satisfactory, and the instruments were converted to other uses.

We have cooked liner board stock using direct and indirect steaming; also with direct steaming with and without circulation. We have cooked pulp for the bleach plant using the same methods and are at the present time cooking all our pulp using direct steaming and no circulation. At the present time, we are well pleased with our time cycle steaming controllers and our automatic gas-off control instruments.

GAS-OFF CONTROLS AND TIME CYCLE STEAMING

We have one connection for our control instruments about 2 feet down from the top of the digester. This is a pressure tap which has a small amount of water bled into it to keep it from plugging with stock. The time-cycle controller controls the pressure of the digester by admitting steam to control the pressure of the digester as per the curve cut on a cam which is nothing more than a cam-operated pressure controller. The gas-off controller is also connected to this same pressure tap. The thermometer bulb on the gas-off controller is located above the strainer and in the gas-off line from the digester; the gas-off controller records the pressure in the digester and the temperature of the gas-off vapors. The function of the instrument is to keep the pressure temperature differential within a relatively narrow range. We have several digester steaming charts here which are the charts made by the gas-off controller as was just described. Please do not misunderstand—we are not trying to sell gas-off control instruments, nor this particular type of gas-off controller instrument. We understand that there are now several instrument companies who make gas-off controllers that operate on different principles.

In any gas-off system, the strainer plays a very important role. We have found that the method of steaming the digester also has a great deal to do with the operation of the gas-off system. At the present time we steam our digesters rather vigorously until the digester reaches 30 pounds, then cut back on the steaming for several minutes until the digester has had time to clear itself of gases, and then bring the pressure on up as desired. It seems that the digesters settle down and do not try to carry over, nor does the strainer tend to get plugged and packed. As a rule there is a very loosely formed coat of fibers over our strainers of from $^1/_{16}$ to $^3/_{16}$ inch thick. We believe this coating forms early in the cook as it usually has a large percentage of raw sawdust and poorly cooked wood particles in it. We also think this coating is a fine thing and that it acts as a filter and gives clean gas-off gases for the control valve.

Digester gas-off screens have been experimented with in Plymouth over a very wide range. We first started out with a screen which filled the neck of the digester and was in the shape of a half of a sphere, and then went to a round strainer which fits in neck of the digester; then to a foot-square strainer on one side in neck of digester, then to screens in the flanges in gas-off line, and are now back to a foot-high circular strainer which fits in neck of the digester and which is removed and cleaned after each blow. The strainer is made of stainless steel plate with 0.01-inch perforations. We are convinced that to a very large degree, the proper operation of our gas-off controllers is due to these strainers.

DIGESTER CIRCULATION PUMPS AND STRAINERS

In the original digesters installed in 1937, there were strainers in the bottom of the digesters. Later we installed strainers a third of the way up from the bottom of the digesters and returned the liquor to the bottom and top. Our next digesters had strainers just above the cone returning some liquor to the bottom of the cone but most of it to the top of digesters. The four digesters installed in 1945 had a perforated torpedo in the center of digester just above cone and the liquor was returned to the top and some to the bottom of the cone. We had considerable trouble with the torpedo collapsing and breaking loose and we finally installed strainers at top of cone where they seem to work best.

We started out with a 1000-gallon per minute pump, then a 1500-gallon per minute pump, and on the final setup we bought four 2000-gallon per minute pumps. The original pumps had shallow packing glands and were difficult to pack and to keep packing in place. The final pumps had very deep, well-designed packing glands and gave no trouble mechanically. In our experiments and trial periods of cooking and steaming the digesters direct and using circulating pumps, we burned several cooks of chips. The chips were actually charred and looked as though they had been in a fire when they came over the washers due to the pumps pulling the liquor away from the bottom of digesters around the steam

THE CORRECT COMBINATION FOR SUCCESS—In addition to good instrument performance the success of this installation is also due to the willing and complete cooperation of the Brunswick Pulp and Paper Company with the Bristol organization in the engineering, installation, and operation of the control equipment.

"Outstandingly Successful Automatic Control"

Bristol Digester Control Gives Complete Satisfaction at Brunswick Pulp and Paper Co.

As reported by Brunswick, the results obtained from automatic control system include (1) saving in steam, (2) pull-over of liquor minimized, (3) ideal cooking schedule accurately and consistently repeated, (4) practically no maintenance required, (5) results fully satisfactory.

Like all Bristol control systems, this one is simple, adaptable. Operating men get familiar with it fast. Control panel units can be installed side-by-side to form a continuous panel for controlling an entire digester house, and can be enlarged to cover more digester.

Bristol Instruments Get the OK in Mills from Coast to Coast

Experience at Brunswick Pulp and Paper Company is typical of the performance of Bristol Recording Instruments and Automatic Control Systems in Paper Mills from coast to coast.

Bristol manufactures a complete line of automatic controlling, recording, indicating and telemetering instruments and component equipment for the Pulp and Paper Industry to take care of applications requiring from only one or a few instruments to those requiring extensive instrument control panels.

NEW SERIES 500 INSTRUMENTS ARE NOW AVAILABLE. Products of over 60 years of instrument experience, they are extremely simple in construction and will withstand the severest service. They require practically no maintenance—anybody can take care of a Bristol Series 500 instrument.

Bristol Has the Resources Needed to Give You the Best in Instrument Engineering

Bristol has developed techniques and facilities for handling even the most difficult and unusual control problems. Our engineers will relieve you of many worries by providing layout drawings and piping and wiring diagrams. We furnish panels in finished form with all internal piping and wiring complete. All you have to do is make main power and air-line connections. Our engineers stay with the job until operating satisfactorily.

Make use of Bristol resources. Write for Bulletins. THE BRISTOL COMPANY, 102 Bristol Road, Waterbury 20, Conn.

Quick Facts About Bristol Alkaline Digester Control System

Bristol Alkaline Digester Control System is used to automatically control digestion of Southern pine and Northwestern fir and hemlock in direct and indirect-steamed digesters, with either forced or natural circulation of both long and short cooks. *Installation requires no changes in digester equipment. It adapts itself to the digester, resulting in lower installation cost.* It is also adaptable to changes in operating conditions.

THE DEPENDABLE GUIDEPOST OF INDUSTRY

BRISTOL

AUTOMATIC CONTROLLING. RECORDING AND TELEMETERING INSTRUMENTS

inlet nozzles. We overcame this by throttling back on the pump discharge valves and slowing the rate of circulation in digesters so that the chips in the bottom of digesters were always flooded with liquor. However, we ran quite a few test periods of a week using the circulators and a week without the circulators and could find no advantage. On our digesters with conical bottoms we added some steam at bottom of cone so that there would not be a dead spot in the bottom. The majority of steam is added through two nozzles about a third of the way up the cone. Each nozzle is divided inside the digester into two streams—each shooting in opposite directions about 45° from the bottom of digesters.

Our early experience with indirect heaters was not good. We had tubes plugging with scale, tubes cracking and breaking from improper operation of expansion joints, and our fair share of trouble with gaskets and steam traps. Our later heaters are better designed and instead of using steam traps we used condensate tanks with float level controls on them which eliminated hammering and the other troubles we had using traps. However, the power department maintenance crews still had plenty of work replacing blown-out gaskets and keeping down liquor leaks at sight glasses, etc.

We realize that there is considerable economy in returning the condensate from the digesters to the power plant, however, we have not been able to prove that better pulp could be made using indirect heaters and circulating pumps and with the maintenance cost high on maintaining the heaters, the power department is not sure that the condensate is worth the maintenance.

Mr. J. N. McGovern presented the third paper "Effect of Bark on Yield and Quality of Sulphate Pulp from Southern Pine" by J. S. Martin and K. J. Brown, Chemical Engineers at the Forest Products Laboratory, Forest Service, U. S. Department of Agriculture, maintained at Madison, Wis., in cooperation with the University of Wisconsin.

Experiments were conducted on the sulphate pulping of shortleaf pine (*Pinus echinata*) chips containing 0, 8, 16, and 24% of bark that had been previously separated from the wood and cut to chip dimensions. Bleaching, kraft, and semichemical pumps were made from each mixture of bark and wood.

An important disadvantage in the use of bark for making pulp was shown by the 15% yield of screened pulp obtained by cooking bark alone as compared with 48% from a standard kraft digestion on wood alone. With 10% of bark present, yields of bleaching and kraft pulps were 2.5% less than those obtained when bark was not present. If 10% is considered to be the average amount of bark on pulpwood, however, the fiber yield from a cord of rough wood would be increased 5.4% by not removing the bark. Pulp strength was not affected when as much as 16% of bark was present, but the chemical consumption was increased and the pulps became darker and more difficult to bleach with increasing amounts of bark.

In producing sulphate semichemical pulp under conditions that give a yield of nearly 60% from wood alone, the yield of pulp was little affected by as much as 24% of bark. The strength of the pulp, however, decreased considerably with increasing amounts of bark.

These experiments indicated that considerable percentages of bark can be used in kraft-type pulps with no sacrifice of strength and with higher yields of fiber per cord of rough wood and the elimination of barking expenses. Disadvantages indicated were higher chemical costs per unit weight of material processed and increased difficulties in washing and handling. The use of bark in the sulphate semichemical process can increase the yield per unit volume of rough wood with only a slight increase in chemical consumption but with a considerable loss in pulp strength.

This paper was followed by "The Continuous Manufacture of Semichemical Pulp for Corrugating Board," by J. McK. Limerick, Bathurst Power & Paper Co., Ltd., Bathurst, N. B.

As a means toward the conservation of natural resources the Bathurst Power & Paper Co. has for some years been increasing its yield from the softwood species. This has been followed by the production of corrugating board from all available species of hardwoods by a continuous process. Thus, complete utilization and over-all conservation are being practiced.

A description of the mill is given. The continuous process is also described, including chipping, chip and chemical feeding, cooking, refining, washing, and board making. Pulp quality at various states of the process is given.

"Observations on the Operation of the Sutherland High Yield Kraft System," by Lionel M. Sutherland, Sutherland Refiner Corp., Trenton, N. J., was next on the program.

High yield hot brown stock refining was developed by D. Manson Sutherland, and first commercial operation was obtained in cooperation with the Bathurst Power & Paper Co. as reported by Allo. Approximately 270 tons of northern kraft and 1800 tons of southern kraft high yield pulp are now being produced daily with additional installations contemplated.

Current yields are around 62% on northern kraft and from 56 to 60% on southern pine which compares to normal yields of around 47 to 48% in pulps cooked for production of kraft liner board and 45% or less for most grades of kraft paper.

Introduction of hot brown stock refining into the pulp mill has created some operating problems most of which can be overcome by practical means.

Changes have occurred in operation of vacuum washers where a loss of capacity of approximately 15% may ensue arising from a small drop in freeness of hot-refined pulp, improved felting power of the refined fibers and a hard air foam, if present.

An increase in power consumption of $1^1/_2$ to 2 hp.-days per ton of liner board may be anticipated when 60% yields are approximated at chlorine numbers of 15 to 16.

On southern kraft pulps evaporators may require more frequent boil-outs although this has not been the case in cooking northern kraft pulp at Bathurst. Several causes for this condition have been recognized and successful steps to minimize this condition have been taken.

The effect of hot brown stock refining on southern kraft pulp is similar to that obtained with any mild refining treatment. Improvement is noted in burst, tensile, and tear when high yield pulp is compared to samples of normal kraft obtained from a group of mills.

The kraft liner board produced easily meets industry standards and works well in customers' box shops as evidenced by production of about 2,000,000 tons of high yield kraft since the process became established on a commercial basis.

High yield pulps can be bleached to produce pulps of 82 G.E. brightness with bleached yields of around 50% and show excellent strength characteristics. Consumption of chlorine is high and the economics of the process have not been fully explored.

Savings in wood of 20 to 25% are being obtained and improved cooking techniques may result in still higher yields. Savings in wood, labor, steam, and chemicals amount to around $5.00 per ton with a wood cost of $15 per cord. On this basis a 500-ton mill can save up to $850,000 operating 240 days per annum thus paying for a complete high yield kraft system in less than 8 months.

High yield pulps are believed to be suitable for most grades of paper, although the upper limit of yields for paper grades may prove to be around 55% rather than the 60% yields, and better, now being obtained in liner board grades.

The chairman then introduced Malcolm M. May, formerly of the Institute of Paper Chemistry and presently with the Champion Paper & Fibre Co., Houston, Tex., who read a paper entitled "Chemical Reaction Equilibrium in the Combustion of Sodium Base Pulping Liquors."

The results of an investigation of the chemical reaction equilibria in the combustion of sodium base pulping liquors employing thermodynamic principles to calculate the equilibria in certain basic reactions involving all of the compounds which might be expected to exist in a sodium base system under recovery conditions were given. From these basic reactions other reactions of interest were derived and their equilibria were calculated.

CHAIRMAN: Since Mr. May must catch a plane this afternoon and will be unable to attend the discussion period, we will throw the meeting open for any questions or discussion on Mr. May's paper.

MR. EDWARDES: What is the chance of controlling the oxidation of sodium sulphate in solution and stopping the reaction to sodium sulphite in the presence of air and oxygen at a combustion temperature?

MR. MAY: I doubt that this can be controlled because

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there is a strong tendency for the sodium sulphide to be oxidized to the sulphate.

Mr. Stevens: Are there any preprints available or must we wait until this is published?

Mr. May: Unfortunately there are no preprints yet available.

Mr. Gilmont: If you have your sulphur dioxide in the gas phase and your sodium carbonate in the solid phase, do you expect to get sodium sulphate at temperatures of 300°?

Mr. May: The equilibrium is favorable but the rate of reaction is not known.

Mr. Yundt: In this whole discussion, do not forget that there is the equilibrium and also the rate of reaction.

Mr. May: Yes, as Mr. Yundt has pointed out, all this information is simply in equilibrium, and for these fourteen basic formation reactions you can calculate the equilibrium conditions, but nothing can be said in respect to the rates of reaction.

Chairman Fuller: Thank you, Mr. May. Such a paper as you have given requires careful study. We will now have two further papers to complete this morning's session—after which we will adjourn for luncheon.

Malcolm B. Pineo, Brunswick Pulp & Paper Co., read a paper on "Cooking Southern Wood for High Brightness Bleached Sulphate Pulp."

The production of southern pine kraft brown stock for bleaching to high brightnesses is dependent upon high liquor-to-wood ratios, high activity of cooking liquors, controlled time-temperature schedules, and uniformity of operations. Liquor-to-wood ratios in the range of 15% or even as high as 18% are desirable. Temperatures not exceeding 345°F. and total cooking times in the range of 4 hours, 15 minutes are requirements for soft bleachable pulps. Sulphidities may be maintained at any level between 15 and 35% with some data indicating that the higher values are beneficial to easy bleaching. Uniformity of operation must be given top priority if the quality of the bleached pulp is to be maintained at a high level.

The last speaker in the morning program was Richard G. Coker of the Sunoco Products Co., Hartsville, S. C.

Neutral Sulphite Semichemical Pulping

Richard G. Coker

A review of the NSSC process is of interest in view of the recent rapid growth in the use of the process and because of the progress that has been made in producing pulps of quality suitable for bleaching and suitable for glassine.

More than 25 years have elapsed since the time of the work of Rue, Wells, Rawling, and Staidl at the Forest Products Laboratory which resulted in the revival of interest in semichemical pulping. It was the enthusiasm and confidence of these men, and their careful and thorough experimental work which led to the commercial adoption of the process in the pulping of spent chestnut chips from tannic acid extraction plants and later to the pulping of southern hardwoods. Progress was slow for a number of years, perhaps largely because of the state of the general economy and the overproduction of the paper and paperboard industry. Another reason for the slow progress of the adoption of the process lay in the fact that truly suitable refining equipment was not available or had not been found.

The basic method of cooking by the use of neutral sodium sulphite mixed with sodium bicarbonate is relatively unchanged today from that proposed in 1924, but the concept of refining the softened chips produced by the cooking has undergone radical changes. The original refining proposed was by the use of the rod mill, and it did the work after a fashion. Other refiners were proposed and many were tried with varying success. It is interesting to note the comment of Rue in 1925 (*1*) "Attrition mills are finding some use in disintegrating treated chips, and their application will doubtless by extended as their performance is more thoroughly studied and understood." The attrition mill, now almost always used for the primary disintegration of semichemically cooked chips, did find application in the process at an early date, but did not produce a pulp free of "shive" until a new way of using the attrition mill was adopted.

The new way of using attrition mills may be described in the phrase "hot refining in the presence of the liquor." The difficulty in the early application of this appealing idea, which many people had thought of, was that severe corrosive conditions were encountered unless the cooking was done in a manner to produce a cook definitely alkaline at blowdown. Stainless steel construction in attrition mills was not available until their use in the process had been firmly established.

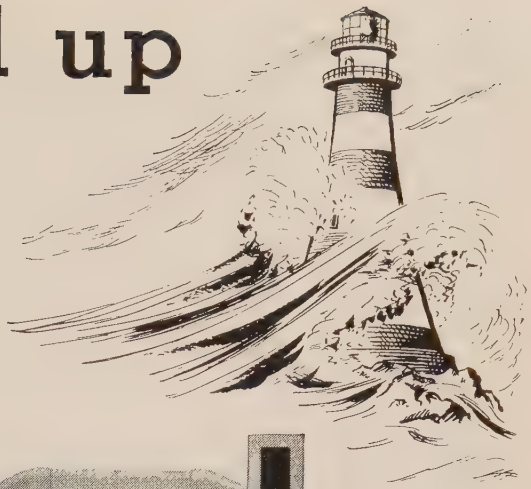
At this point it may be of interest to review some of the variations in cooking by the NSSC process. It is recognized that the more active cooking chemical is sodium sulphite. In the process of digestion acid products are released by the wood, and unless alkali is present to counteract these acids corrosion of a steel digester will occur. To maintain the alkalinity sodium bicarbonate is used with the sulphite. If large amounts of chemical are used, in order to cook to a low yield and high quality of easily refined pulp, then a high ratio of sulphite to bicarbonate may be used. But since the organic acids from the wood must be neutralized, the alkali present must remain in constant proportion to the wood, and as the yield is increased with the use of less total chemical, the ratio of sulphite to bicarbonate must be lower. Unless such lower ratio is maintained, corrosion of the digester will result.

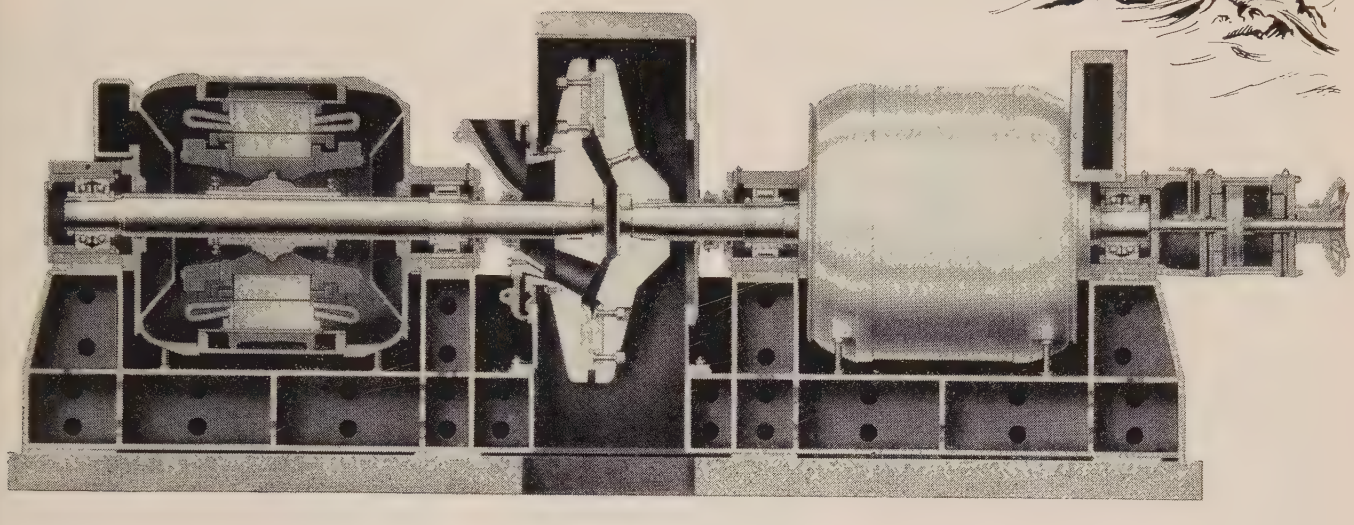
The process will produce pulps of excellent white color if the ratio of sulphite to bicarbonate is kept high, and corrosion in a steel digester is not excessive even though the liquor at blowdown is at pH 6.0. This apparently results from a protective film, probably a sulphide, deposited during the cook. Such acid cooks are extremely corrosive after the pressure is released and the chips are removed from the digester, so that "hot refining in the liquor" cannot be practiced unless stainless equipment is provided not only for handling, primary refining, and pumping, but also for washing. When such corrosion-resistant equipment is provided, refining can be effected with economy in the use of power and the problem of "shive" is greatly reduced. In cooking for highest yield for making 9-point or other boards where a dark color is not objectionable, a lower ratio is normally used, but it is recognized that if stainless digesters were used a chemical saving would result by the use of sodium sulphite alone. In general, it may be said that in cooking hardwoods for best results in bleaching a cook with a high ratio of sulphite to carbonate (or without bicarbonate if corrosion-resistant equipment is provided) will give best results. If hemicellulose is to be preserved for easy beating pulp suitable for glassine, then alkali should be present. In either case, hot refining is beneficial and permits defibering without developing excessive blocks or shives. In cooking pine by the NSSC process, it is possible to develop excellent strength, though not strength comparable with pine sulphate pulps. McGovern and Chidester (*2*) produced semichemical boards from jack pine which were equal in burst, higher in tensile, and lower in tear than southern pine kraft. With pine an alkaline cook is necessary in order to remove rosin, and total chemical is required up to 20% based on the moisture-free weight of the wood. In the cooking of hardwoods for 9-point board, a chemical use of the order of 10% on the moisture-free weight of the wood will produce good results at yields of 75 to 80% based on moisture-free wood.

While the major development of the process has been directed toward the production of corrugating board, we may expect further rapid growth in the production of pulp for bleaching. On bleaching the NSSC hardwood pulps show remarkable strength development with phenomenally low use of power for refining which indicates for the process an

built to stand up

and take it





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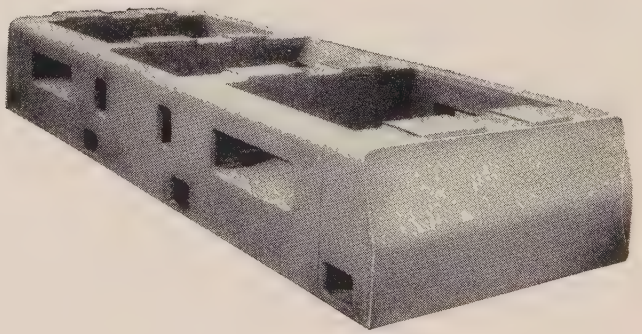

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expanding place as a part of the furnish for white papers. Chlorine requirements will range from 10 to 30% based on pulp weight. Yields of bleached pulps, based on the wood, range from 55 to 85%. Strengths of the bleached pulp range substantially higher than commercial bleached softwood Mitcherlich sulphite pulps (*3*). Here again the problem most complained of has been the difficulty of avoiding shives, but it is evident that this problem is being solved.

The NSSC process is currently practiced by the use of rotary digesters, stationary digesters, and continuous digesters. Strong claims can be made for advantages of each type of equipment, but it is believed that until continuous digesters allow substantially longer cooking time they will require, even at the higher pressures, more chemical to produce quality of pulp equivalent to either rotary or stationary digesters. Of less importance, but still a factor of cost, is the greater use of steam per ton of pulp required in the continuous digester arrangements currently operating. As against these extra costs it is generally agreed that less labor is required for the continuous system. A decision as to what type of equipment should be used must be made with consideration of the quality of pulp desired and also of the relationship to other mill factors. If the NSSC chemicals are to be recovered for reuse in the sulphate process, then best chemical economy may mean little. In another case stationary digesters may be indicated to permit alternate use of the same equipment for sulphate and for NSSC pulping.

Both continuous digesters and stationary digesters may be blown to modern high density blow tanks, and flash steam may conveniently be recovered to heat water for washing. In the case of the continuous digester, it is pulp that is blown to the blow tank, and further handling to refiners presents no problem. If stationary digesters are used, then semicooked chips are blown to the blow tank, and while it is possible without difficulty to pump chips and liquor out of the blow tank, it has sometimes not proved easy to feed the combination uniformly to primary refiners. Best practice appears to favor separation of the liquor from the chips, to permit control of chips for feeding, and reintroduction of the liquor into the flow of chips ahead of primary refiners. This appears to be a somewhat roundabout method, yet uniform feed to chips at constant consistency to refiners is of such importance that every effort to achieve it is justified. In some operations with stationary digesters it is possible to control the flow and consistency without separating the chips from the liquor, but it is not easy, since the accomplishment of such control almost always involves delivering too great a flow, and returning the excess to the blow chest, which is difficult to do with a mixture of chips and liquor that tends to separate when separation is not desired. Doubtless this problem will one day be solved quite simply. It is perhaps well to recall how long the matter was debated, and how much concern was given the question of successfully blowing semichemical cooks from a stationary digester, a thing that now appears quite simple.

With the use of rotary digesters the problem of getting from batch cooking to continuous refining has been solved by the use of that peculiar but practical mechanism called the leach caster. For the benefit of some who may not have seen a leach caster, this device may be described as an arrangement of rotating rakes, progressively lowered, which rake the cooked chips out of a vertical cylindrical tank, dropping them through a hole at one side of the bottom of the tank. The cooked chips, of course, are dumped from the rotary digester into the tank. To make the hole through the mass of chips is easy if an air hose is put in place at the side of the tank before dumping the digester, and then the air is turned on and the hose slowly pulled out. This scheme was thought of after years of punching the hole with a stick, which is very hard work.

Heat recovery from blowdown of the rotary digester is easy and complete for it is possible to blow all of the liquor out of the digester before dumping, and this liquor can be blown into the strong liquor tank of the washer system from which it is pumped for dilution at primary refiners and ahead of washers. The steam from digester blowdown can be directly condensed in the same tank of liquor.

With the rotary digester-leach caster system it is also of first importance to feed the chips uniformly to the primary refiners, and this involves supplying an excess and returning part of the source. With a single digester an accumulator tank is required, but with multiple units and adequate control of leach caster feed the excess can be returned to the conveyor system in a kind of run-around.

A number of variations in cooking and handling are in commercial operation. One system involves preliminary soaking in hot liquor at atmospheric pressure, followed by cooking in a continuous digester. Another scheme uses preliminary cooking at low pressure in rotary digesters, followed by cooking in a continuous digester. The latter is probably used because of local plant conditions and to utilize existing equipment, but it is interesting in that it demonstrates the flexibility of the process and produces an excellent 9-point corrugating.

The process is applicable, as has been noted, to both hardwoods and softwoods. Different cooking is needed for softwoods from that best for hardwood, so that good results cannot be expected from mixtures. Similarly it is best to avoid mixtures of the so-called hard and soft hardwoods. Hickory is particularly objectionable when cooked with blackgum and sweetgum, though small amounts of poplar and oak can be mixed without too much difficulty.

For the NSSC process a short chip ($^1/_2$ inch) is of importance to insure complete impregnation with the liquor and to avoid uncooked centers which cause shives. Oversize chips should be carefully screened out and rechipped or crushed. Sawdust should be removed in order to remove dirt and bark, and because the blocky shape is difficult to refine and may cause block shives, or at best contribute to the production of excess fines. Bark is always objectionable because it consumes more than its share of chemical and it always produces a product of lower quality. In pulping for bleaching care in wood preparation and chipping can hardly be overemphasized. The ideal situation is to have an operation on coarse pulp for board alongside the pulping for bleaching, and to use only the sound, straight, fully barked wood for making pulp for bleaching.

No attempt will be made in this brief discussion to review the problem of recovery of waste liquors. It is believed that the intensive effort now being directed to the solution of this problem will soon produce a workable system of recovery that will not only eliminate the difficulties due to stream pollution but will recover chemicals on an economic basis that will permit the NSSC process to stand on its own merits without the necessity of leaning on a sulphate operation for cross recovery. When such a system of recovery is developed we may expect to see the process move forward to further growth, especially in localities where hardwoods are available and are not extensively used for pulpwood.

The process is a simple one which can, if the solution to the recovery of waste liquors does not complicate it too greatly, be economically built and operated in units of smaller capacity to make both corrugating boards and bleached pulps.

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Thursday Luncheon

Leonard A. Blackburn, President, Slaughter, Saville &

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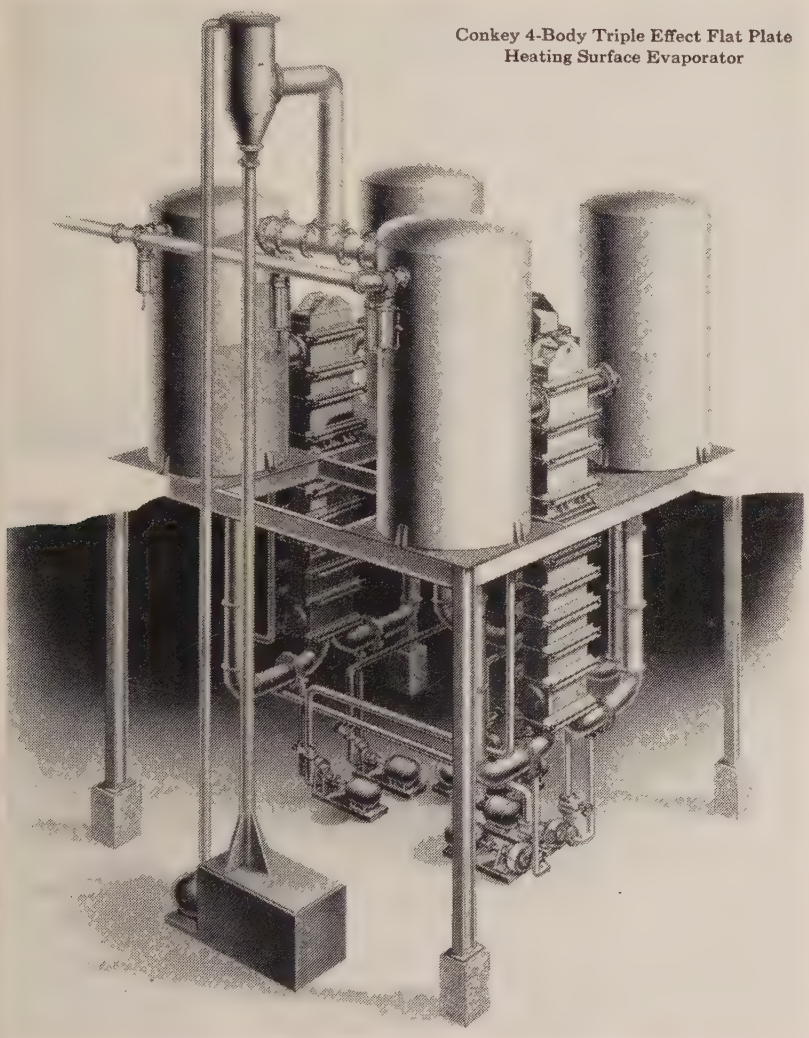

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Blackburn, Inc., of Richmond, Va., was the guest speaker at the luncheon on Thursday, held on the Roof Garden of Hotel John Marshall. Mr. Blackburn's topic was "What is Wrong with the Free Enterprise System?" It was evident from his remarks that Mr. Blackburn considered that there was very little wrong with the system of business enterprise in the United States but that many businessmen had neglected to make their influence felt in Washington. The speaker suggested that businessmen constantly inform their Congressmen and Senators of their objections to increased bureaucratic controls and do everything they can to discourage the expansion of Federal agencies. On the contrary, the speaker suggested that business management should use its influence on the local levels to discourage the use of Federal funds whether in the form of loans or grants. Unless this is done, Mr. Blackburn said that the liberties of free enterprise and the constitutional rights of American citizens would be dissipated by the growth of Big Government in Washington.

Thursday Afternoon

CHAIRMAN FULLER: The afternoon session will please come to order and we will have the first paper "Semichemical Pulping and Wood Species," by J. N. McGovern and E. L. Keller of the Forest Products Laboratory, Madison, Wis.

An empirical method of classifying wood species according to their semichemical pulpability was described. Woods commonly found to be pulped readily commercially were classified by the given system as first class, whereas others fell into second and third classes. Among the first-class woods were, aspen, birch, maples, tupelos, and gums. The second-class woods included ashes, hickories, red alder, and several softwoods. Other softwoods were classified as third class. The lignin content and density of the wood were not found to influence the classification. There was evidence that the permeability might have an influence.

CHAIRMAN FULLER: It is a real pleasure to introduce our next speaker—Mr. Paul Lange of the Swedish Forest Products Research Institute, Stockholm, Sweden.

Mr. Lange then presented a paper titled "Distribution of Cellulose and Hemicellulose in the Cell Wall of Sulphite Pulp in Comparison with Other Pulps." This paper will be published in a later issue of *Tappi*.

C. L. Durke of D. J. Murray Manufacturing Co., Wausaw, Wis., presented a brief discussion of the M.B. Continuous Digester describing the equipment and the method of operation.

Panel Discussion

CHAIRMAN FULLER: We will now hear briefly from a number of people in our industry covering various phases of alkaline cooking. To start this off, I would like to talk for a few minutes on a "Review of Methods of Determining Degrees of Pulping," after which various people in and connected with our industry will discuss various subjects of cooking as listed on the program. After the last paper we will throw the meeting open for discussion.

In this review Mr. Fuller pointed out that the various methods which are employed for determining degrees of cooking and ease of bleaching may be summarized as follows: (1) Tests employing oxidizing agents including (a) permanganate test (TAPPI), Bjorkman, and other permanganate tests; (b) Roe chlorine number; (c) Tingle number; (d) hypochlorite test. (2) Lignin determination (3) Staining techniques. (4) Absorption methods.

Hard Cooking of Northern Woods, by John P. Lunderville, Brompton Pulp & Paper Co., Red Rock, Ont.

NORTHERN coniferous woods seem to be generally recognized as excellent raw materials in the manufacture of most kinds of wood pulp. With all the advantages there are, however, certain drawbacks were imposed mainly by the rough remote areas in which they grow.

Climate and rugged terrain create difficulties in transportation which necessitate a complicated system of handling and storage usually rendering it impracticable to attempt segregation of species and difficult to control seasoning.

Worst of all, the complicated movement and storage lead to high cost.

Stimulated by this high cost, attempts are being made at Red Rock to obtain the highest possible yield of pulp from the wood with the equipment available.

The operation under discussion is a single fourdrinier machine mill making both 9-point kraft corrugating and 16-point liner board. Average daily production is approximately 260 tons.

The pulp mill is a fairly conventional installation. There are four 3000-cubic foot digesters using natural circulation and direct steaming with manual control throughout. Vacuum washers are used followed by vibrating knot screens and centrifugal fine screens. There is a somewhat haywire arrangement for refining knots and rejects which will be described later. All the rejects ultimately find their way into the paper machine furnish or surplus pulp which is lapped and sold.

The recovery system consists of a Combustion Engineering furnace, Swenson six-effect evaporator, Dorr continuous causticizing system, and a lime kiln.

Capacity is 280 air-dry tons a day.

Until two years ago, because of a strong prejudice on the part of the papermakers against the use of hard stock, pulp was cooked to a permanganate number of approximately 30.

The prejudice was finally overcome, and since then the pulp has been progressively hardened up to achieve a gain in yield of 7%. Aside from the obvious advantage of utilizing an additional 7% of the wood, it is felt that the harder pulp is more suitable for our purposes.

Anything accomplished, so far, has had to be done with virtually no changes in equipment. Certain modifications in technique were necessary to attempt to hold the screen rejects to a minimum.

The first problem was the evolution of a cooking cycle which would give the most uniform pulp possible and at the same time meet the demand for production.

As previously mentioned it was necessary to make up to 280 tons in four 3000-cubic foot digesters. This allows a maximum cooking time of 2 hours and 20 minutes.

Uniform liquor penetration was considered to be of utmost importance. Various schemes such as steaming chips or shutting in for varying periods during the initial stages of the cook were tried. They may have helped somewhat, but were impractical because of the time lost performing them.

It was finally concluded that the employment of a low charge of active alkali, the longest possible time to maximum temperature using a gradually increasing rate of temperature rise as the cook proceeded, and the shortest possible time at maximum temperature produced the best results.

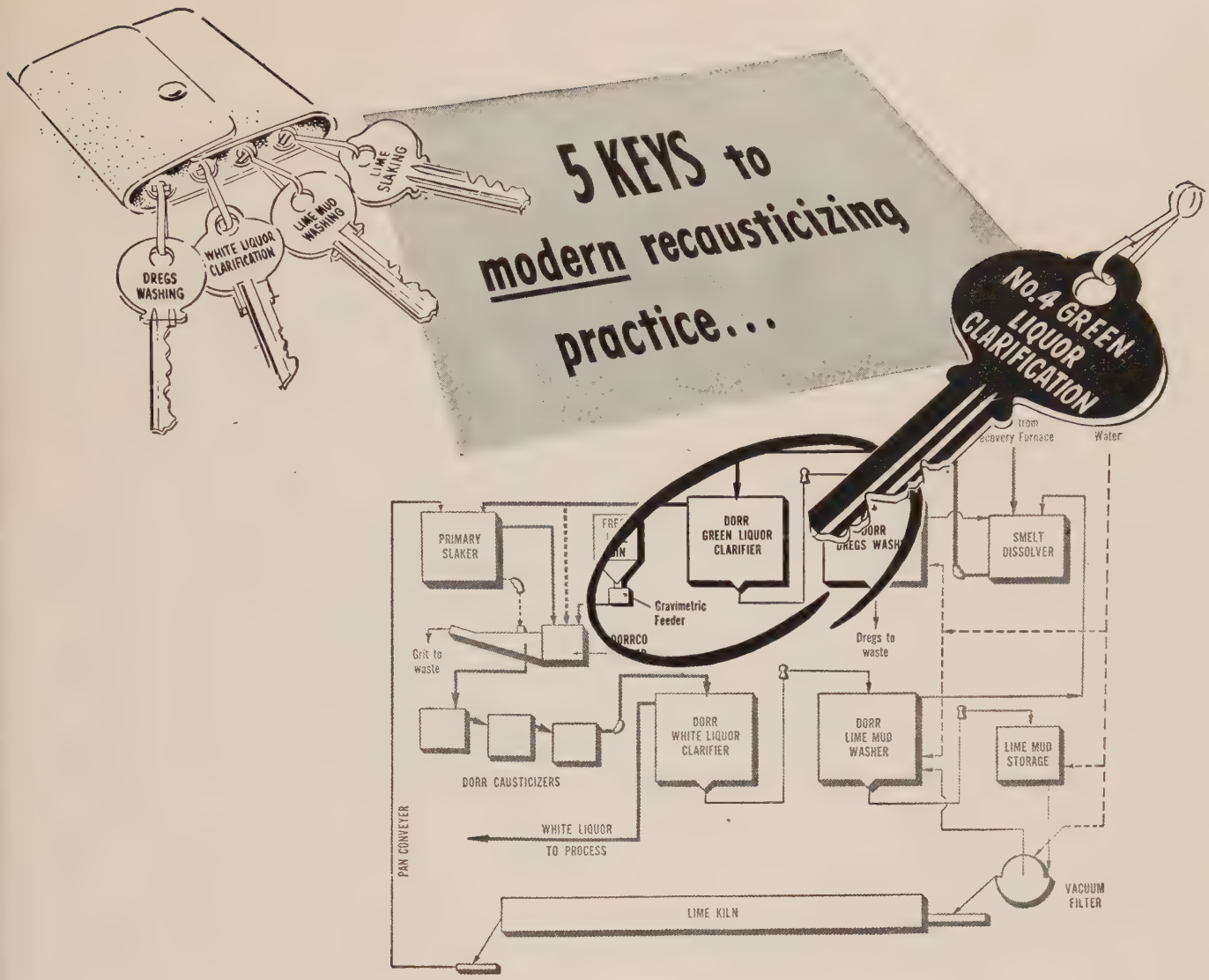
Dilution in the digesters is held as high as possible but is limited by the fact that heavy relief or gas-off is necessary as an aid to circulation.

Even under what were considered the most favorable cooking conditions attainable, the percentage of uncooked chips increased rapidly as the pulp was hardened up.

This was blamed on a lack of uniformity of liquor penetration due in part to varying mixtures of wood species, to variation in moisture content, and to some irregularity of chip length.

It was thought that the effect of these variables would be reduced to a minimum by reducing the size of the chips.

Consequently the chips which were originally cut $^5/_8$ to $^3/_4$ inch long were shortened to $^1/_2$ inch and attention was given to the uniformity of length.



Delivering green liquor of uniform clarity to the Slaker is a must in ideal recausticizing practice. In the Dorr System—the standard of the Alkaline Pulping Industry—the Green Liquor Clarifier combines adequate area and detention with positive, continuous dregs removal by an adjustable-stroke diaphragm pump.

The net result is . . .

- **No accumulation of iron, aluminum salts or other inert material in the lime circuit.**
- **Maximum CaO availability of reburned lime is constantly maintained.**

Green liquor clarification is only one of the important unit operations in The Dorr System. A new bulletin, #3301, describing the recausticizing operation in detail, will be sent on request. Address inquiries to The Dorr Company, Stamford, Conn.; or in Canada, to The Dorr Company, 80 Richmond Street West, Toronto 1.

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Results were highly gratifying. Knot screen rejects were substantially reduced with no apparent adverse effect upon pulp quality.

Present production of rejects from the knot screens and secondary fine screens is approximately 4% of total pulp production.

The uncooked or partially cooked knots and chips are broken up in swing hammer shredders, mixed with fine screen rejects refined in a small Haug refiner, and a jordan set up in series then rescreened and ultimately returned to the machine furnish.

It should be mentioned here that, so far, Canadian converters do not show the same concern over moderate quantities of dirt in the board as the American box manufacturers appear to do. Our chief requirement is a high finish which will resist ink penetration and facilitate high gloss printing.

Concurrent with attempts to harden up the pulp, changes were made in paper machine operation to improve the finish on the board.

For this reason it is difficult to accurately assess the effect the harder pulp had on machine performance.

There has been no apparent adverse effect on paper machine speed. A slight improvement in drainage has resulted. Considerably more power is required at the paper machine refiners, but better control of furnish is possible.

There has been a significant increase in bursting strength. The development of adequate bursting strength without serious loss in tear and bulk is of importance in the Canadian market where standards of strength and high caliber must be maintained.

While there may be no significant improvement in operation arising from the use of harder stock, no disadvantages have been found and the economic gains resulting from increased yield are obvious.

It is felt that no further progress can be made at Red Rock without modification of the existing plant to permit hot stock refining.

Experience indicates that it would be both technically and economically sound to proceed with these changes and thus permit the extension of the program to affect further savings of both money and wood resources.

Sprout-Waldron Single Rotary Disk Refiners, by Thaxter W. Small, Jr., Sales Engineer, Sprout-Waldron & Co., Inc., Muncy, Pa.

In the nature of achievement—of the total tonnage of semichemical pulp produced in the United States during the year 1950—over 50% was processed through our single rotary disk refiners. For the year 1951 we have already completed plans for handling an additional daily production of 1200 tons and more, exclusive of foreign developments.

Our operations range from the refining of pulp for corrugating, liner, specialized use as extenders in such grades as board, bottle cap, match stock, newsprint, insulation products, up through and including the highest quality pulps for bleaching and use in bonds, mimeo, ledger, and writing.

Since our installations are located over much of the United States geographically, accordingly, we have had considerable experience refining various species and combinations of hardwoods, softwoods, and vegetable fibers.

In the field of prerefined high yield kraft, we are successfully processing one of the hardest cooked pulps in the pulp and paper industry today.

Whereas our present installations on prerefined kraft are located in the Southern United States, we will very soon be in production on West Coast woods.

The success and popularity of Sprout-Waldron single rotary disk refiners are the result of determined progressive accomplishment through the combined efforts of our customers throughout the industry and our skilled staff of engineers. Through working together we have a refiner that is "mill-proved" and "tailor-made" to suit your individual requirements.

Because of the flexibility offered through such features as our: (1) adjustable peripheral control mechanism whereby we can restrict or regulate the rate of stock discharge and hold it back in the refining zone to accomplish the desired amount of fibrillation, hydration,or whatever action is wanted; (2) our interchangeable screw feed inlet for high consistency stock and fluid feed inlet for low consistency stock; (3) our 9 to 1 ratio heavy geared adjusting mechanism; (4) dial control indicators graduated in one-thousandths of an inch whereby the operator will know his plate clearance at all times; (5) our three-point suspension system for simplified plate alignment and tramming; (6) our wide assortment of carefully planned and designed plate patterns; you will find our refiner fully capable of meeting your requirements today as well as five years from today at which time your method of pulping may have varied.

The Turbo Refiner, by L. D. Smiley, Gruendler Crusher and Pulverizer Co., St. Louis, Mo.

In order that the terminology of this type or method of equipment is thoroughly comprehended, it must be pointed out that the term Turbo Pulp refining is that method of refining wherein a rotor containing one or more elements is actuated in such a manner as to produce a turbine effect. The prime purpose of this type of machinery is, first, to create centrifugal force and effect. The specific phenomenon for this purpose attached to centrifugal action insofar as the mechanics are concerned, is to take the fullest possible advantage of the effect and efficiency of centrifugal and centripetal work. The axis of rotation is fixed in a horizontal plane while the rotor is so constructed as to have forces acting in three planes.

In utilizing such a mechanism, the obvious factor of impact had to be taken into the deepest consideration. In order that the fiber particles or bundles or individual fibers be not mashed, cut, or destroyed, it was necessary to design into the rotor an axis or center of percussion. The axle reaction of the rotating shaft, if completely fixed, would create direct impact. Therefore, it became necessary to reverse the senses of resultant force and create a couple. This couple was created by the installation of a secondary axis some distance from the primary axis. This then resulted in the mechanical picture of having a rotor, outboard of which was created another axis or shaft upon which were hung flat plates fixed to the outboard axis. This created the equivalent of a pendulum on a turbo rotor.

The rotor then began to assume the configuration of what has been known for years in the reduction industries, namely, a swing hammermill. This, however, did not suffice as such a machine is intended primarily for direct impact. What was desirous to obtain was angular impact in order to achieve the phenomenon of something similar to combing or carding.

It is quite well known that water or liquid, being incompressible, acts as an opposing force to any impact blow. It was then decided to install a water reservoir against which the revolving turbine blades could operate. Considerable work in trial and error was done to achieve all of the structure as well as the internal work surface of the unit. The results not only show that there is no fiber damage but also bear out the fact that another important physical effect takes place and that is one of hydraulic action.

The hydraulic forces surrounding each fiber, or fiber bundle or fiber group, act as a cushion and a direct medium which retards the cutting action of the swing members attached to the rotor. This allows a tremendous centrifugal energy force to be exerted without lacerating or damaging the fiber structure in any way.

Microphotographs show that the fiber lengths produced are

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•

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very desirable and that there is no damage to the fibers after passing through the Turbo refiner.

Most of the most satisfying advantages, definitely existing not only in the laboratory but also in actual mill production runs, are in the ability of the Turbo refiner to create dollars and cents savings resulting in added mill profit. The way that this is accomplished is twofold and quite simple.

First, when the knots, screenings, and rejects are reintroduced into the digester, part of the capacity for raw materials into the digesters is used up. The Turbo refiner having the capacity to take the knots, screenings, and rejects directly from the knotters and flat bed screens thereby makes it unnecessary to put them into the digesters for redigestion, allows for added production through the utilization of an equal amount of standard raw material whether it be chips, groundwood, or pulp stock.

The second means by which the Turbo refiner increases the over-all profit and production is that not only does the additional digester capacity make for higher production but a much greater yield from raw material tonnage results from the reclamation of knots, screenings, and rejects themselves.

The cost of maintenance is extremely low compared with other types of pulp mill equipment, and the power consumption of approximately $5^2/_{10}$ hp. per ton per day is less by far than average mill experience or any kind of refining equipment.

The following data are a part of that which we are submitting for your information and study.

The following test on a hard-cooked caustic soda straw pulp showed a total demand based on 50 tons of pulp, dry basis, in a 24-hour run would create an actual demand of 231 hp.

One-Hour NaOH Hydrapulper Cooked Straw

Greeness (Schopper-Riegler), ml.	*Bursting strength, pt.*	*Ring crush (Riehle), lb.*
1 pass, 620	54	26
2 pass, 610	54	28
5 min.; recirculate, 620	57	29

The following McNett fiber classification was made on a test run of oak in comparison with another type of refiner which we shall call refiner X. The following are the results:

McNett Fiber Classification

Screen size, no.	*Oak pulp mixture from three chemipulpers* *Turbo refiner 1/8 in., %*	*Refiner X, %*
8	1.1	2.3
14	11.5	8.0
28	21.1	15.7
100	49.6	42.4
Through 100	16.7	31.6
Coarseness modulus	114.8	114.9

McNett classifier run for 15 minutes using 10-gram moisture-free samples. Tests run in duplicate and results averaged.
Coarseness modulus is an arbitrary value based on the sum of fraction multiplied by the following factors: per cent on no. 8 mesh by 4; per cent on no. 14 mesh by 2; per cent on others and that through no. 100 by 1.

It is quite apparent from both of these particular test result data figures that Turbo refining creates directly a most desirable cumulation of effects. One of the more noticeable features that we experienced was the fact that the stock hydrates to a very high degree and as evidenced by the freeness factors, creates a condition wherein this becomes conducive to running board machines at higher speeds.

The conclusions resulting from the fiber classification on the oak pulp alone, definitely show a minimum of both extreme coarse shives, namely on 8-mesh screen and also a minimum of fines, namely, that material passing a no. 100 screen.

Brief Remarks Regarding the Chemi-Pulper, by L. S. Durant, Paper & Industrial Appliances, Inc., New York, N. Y.

Mr. Fuller asked me to discuss briefly some of the things connected with the Chemi-Pulper and semichemical pulping. You have had a very long program and there is still more to come, so I will try to confine my remarks to even less than five minutes.

There has been a great deal of talk here today about semichemical pulping and we have had some rather interesting papers, particularly the one by Mr. Limerick of the Bathurst Powder & Paper Co. Some of today's talks dealt with equipment for cooking semichemical pulp continuously.

Paper and Industrial Appliances, Inc., as most of you know, entered the field of continuous cooking through the roofing and flooring felt industries. Pulp for this purpose only needed slight chemical cooking for a matter of 4 or 5 minutes. So the units to obtain this 4 or 5-minute cycle were rather small. The first Chemi-Pulpers for the production of 9-point were installed about 6 or 7 years ago and were actually an outgrowth of the pulpers built for the roofing felt industry.

Since that time we have learned that to produce better pulps more cooking time is needed and whereas the early designs gave us units which allowed cooking times of about 10 to 15 minutes for 9-point pulp, we have found now that with improved designs we can build equipment which will easily allow over 2 hours' cooking time and probably about 2 hours and 40 minutes.

The feeding mechanisms have been discussed somewhat this afternoon and I should like to leave one thought with you before terminating this brief talk. Our company is not simply equipment builders but rather has been a combination of research and development people as well. It is our belief that regardless of whether you cook a chip in the digester, in a pot on your mother's cook stove, or continuously, the same basic chemical phenomena are involved.

Penetration of the chip and permeability of the wood are, therefore, of first importance. We cannot expect the rate of penetration to be increased or the chemical phenomena to be changed simply because we change from a batch system to a continuous system. It is, then, a case of doing something which will help us to attain an increased rate of penetration.

Our company is very aware of this fact and a great deal of our thinking and design work have been pointed toward obtaining this increase in rate of penetration which we think is so essential to the success of continuous cooking.

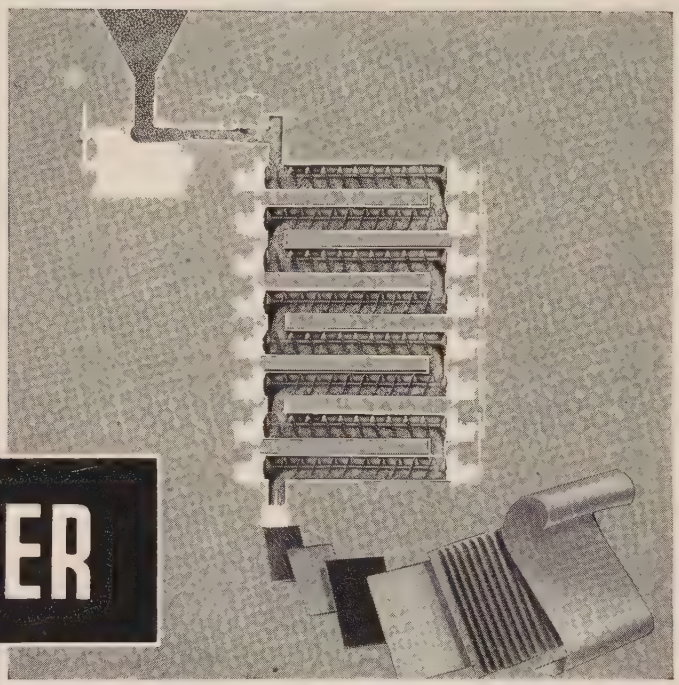
Some Brief Comments on the Current Alkaline Digester Corrosion Situation, by H. O. Teeple, The International Nickel Co., Inc., New York, N. Y.

Of the two alkaline processes currently employed, the soda process appears to be much less corrosive to carbon steel than does the sulphate process. This is evidenced by the fact that digesters installed in the late 1890's are still operating. Also digesters installed as much as 20 years ago are still in service. This does not mean that it would be wise to neglect soda digester inspections because caustic embrittlement is a problem, particularly in the old riveted digesters.

The story of digesters in sulphate pulping is not as simple. Up to about 10 years ago, sulphate digester service life ranged from about 15 years upward. In the period 10 to about 5 years ago, many mills began to note their digesters required replacement more frequently. This fact was noted rather independently in various sections of the United States, Canada, Sweden, and in Australia.

At first it was assumed the various carbon steels used for digesters within this period had changed in some manner. While this was probably true, careful analysis of the sulphate process during this time showed process changes had also occurred.

WHERE WASTE MAKES HASTE *IN* PULP PRODUCTION



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Whether it's pulp wood . . . waste from lumbering operations, forest trimmings or saw mill slabs and edging . . . any piece of wood that is big enough to be handled in a chipper, for conversion into chips, can be used to produce a uniform pulp . . . quickly, continuously . . . and at low cost with the CHEMI-PULPER.

Year after year, more mills realize the value of turning pulp wood and otherwise useless waste into desired grades of pulp to meet specific requirements, using either hard or soft woods, or mixtures of such woods. From portable chippers on the field or regular chippers at the mill . . . chips are conveyed to the CHEMI-PULPER and quickly converted into pulp of uniform quality. These pulps are used for making .009 for corrugating; flooring, roofing and automotive felts, and insulating board.

More than 65 operating units have been installed in the pulp and paper industry . . . units built with from 2 to 8 tubes, operating continuously in 150 to 175 p.s.i. steam pressure range; from 4 to 45 minutes reaction time, and handling up to 100 tons a day of wood chips dry basis.

Your investigation of the CHEMI-PULPER operation as compared to the batch digester will reveal the substantial savings in steam, power, and labor costs . . . with less chip storage, conveying equipment, and pulp storage capacity required for equivalent production.

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The reason, if there be only one, for the increased rates of carbon steel corrosion is quite obscure and is currently a subject for study by TAPPI's Chemical Engineering Subcommittee on Alkaline Digester Corrosion. There is a large number of variables which require evaluation such as type of steel used, cooking liquor composition, cooking cycle, methods of loading the digester, scale pattern in the digester, accurate corrosion rates, type of recovery furnace used, species of wood being pulped, and many others.

In recent years the use of corrosion-resisting alloys has been proposed as perhaps one manner in which this digester corrosion could be alleviated. A number of alloys, type 304, 347, 316, 410, and 430 stainless steels and Inconel have been used. Various types of construction such as field-applied linings, shop-applied linings, and alloy clad steels have been used. Some of these steels have failed for several reasons such as stress cracking, high rates of general corrosion, and intergranular corrosion in heat-affected zones adjacent to welds. It should be noted that the picture is not entirely black for alloys since some of them have performed well in several circumstances.

Another lining material has found some amount of use with rather good results in several instances. This material is carbon brick. If one were to install carbon brick as a field repair lining, one is obliged to accept a decrease in useful digester volume, sometimes as much as 20%. However, if one is planning a new digester, one can compensate for this by purchasing an oversize digester.

Since another type of pulping, i.e., semichemical, has been discussed at this meeting, perhaps it would not be inappropriate to add a few comments relative to digesters for this type of pulping. This is a recently applied process and the specific cooking liquor may be neutral sulphite, sulphate base, or ammonia base producing a semichemical pulp.

There have been reports on high rates of corrosion of carbon steel in neutral sulphite processing. This may be caused by a number of factors, one of which could be a high sulphite to carbonate ratio.

Presumably carbon steel has some basis for use in sulphate semichemical; however, experience with this as well as with other semichemical processes is such that no clear-cut general solution to the problem of the choice of a suitable digester material is apparent.

Advantages of Automatic Digester Controls for Alkaline Pulping, by James M. McAlear, Manager, Pulp and Paper Mill Dept., Mason-Neilan Regulator Co., Boston, Mass.

This very brief paper will attempt to highlight what we consider some of the important points relating to the proper use of automatic instruments for producing uniform pulp. Quite often we find pulp mills who have made sizable investments for automatic digester controls where the instruments actually have practically no governing factor over the cooking process or the uniformity of pulp. Unfortunately, quite often these same controls are producing excellent chart curves. It has been our experience that it is possible to record uniform temperature and pressure curves and yet produce pulp which is unsatisfactory.

Pulp mill personnel must be acquainted with the variables which enter into the digesting of pulp and which produce unsatisfactory results. Some of these important variables are length of cook, pressure, temperature, rate of heat input, quantity of charged liquors, chip weight, chip packing, and rate of relief. Generally it is preferable to initially run off several cooks using hand control but having the instruments take a continuous recording of operations. Such recordings are then a guide for required changes in procedure and after the required quality has been obtained, the automatic controls are then set up to consistently reproduce the same results. If digesters are the same size and cooking the same type of wood to produce the same type of pulp, then the same settings can be used for all instruments without the necessity of handcooking each digester.

Automatic controls on sulphate digesters are employed to govern the heating medium to the process and to control the rate of relief. The method of introducing steam to the digester, and therefore the type of control equipment required, will vary depending upon whether the wood is cooked direct with natural circulation, direct with forced circulation, or indirect with forced circulation. Inasmuch as direct cooking with natural circulation is most common, let us consider the problems involved with respect to the introduction of steam to the vessel. Some of the known values are the size of vessel, the quantity of chips, the volume of liquors, and the type of pulp to be produced. Therefore, there is some correct quantity of steam or B.t.u. value which will cook and circulate the mass over a given period of time. It is understood, of course, that the automatic relief system must be working during the cooking cycle and this will be enlarged upon later.

We prefer to govern steam flow to a direct cooked digester having natural circulation by using a time flow program controller which admits a given quantity of steam or B.t.u. value over a given period of time. Using this system, the quantity of steam is always repeated during the temperature and pressure rise and therefore the same uniformity of pulp is obtained.

Inasmuch as there are always some variables present, it is possible when using a cam-operated flow controller to reach a different maximum digester pressure with the same quantity of steam. Therefore, we use a separate pressure controller in series with the cam-operated flow controller which insures that the same maximum digester pressure is obtained on each cook.

The digester relief system is used to control the discharge of air, noncondensibles, and generated gases. A good relief system should use a temperature and pressure relation controller actuating a control valve in the gas relief line and interlocked with a suitable automatic blow-back system for steam cleaning the relief strainer. Pressure measurement to this controller is taken from the top of the digester and temperature response in the gas relief line beyond the screen. This instrument which is measuring the temperature pressure relationship of the gas can control the rate of gas relief and at the same time can detect a plugged screen or the presence of foam and automatically introduce steam for cleaning or breaking the foam.

In our opinion, the relief controller is secondary in importance to the steam admission control system and it is only the combination of both which produces uniformity of products.

The advantages of automatic steam admission and automatic relief controls on sulphate digesters can be summarized as follows:

1. Uniformity of pulp.
   (a) Reproducible permanganate numbers.
   (b) Reproducible viscosity numbers.
2. More tonnage.
3. Less rejects.
4. Better bleachability.
5. Less steam consumption.
6. Less cooking chemicals.
7. Less man power.
8. Increased turpentine recovery.
9. Graduated steam demands on power plant.
10. Less liquor carry-over.

Remarks by Franklin L. Jones, St. Joe Paper Co., Port St. Joe, Fla.

The St. Joe Paper Co. employs four digesters of all-welded construction having a capacity of 4300 cubic feet each. Direct steaming with 125 p.s.i. steam is employed. Each of four 4-inch steam lines contains a $1^1/_4$-inch orifice plate. The orifice plates are used to assist in obtaining uniform steaming over a given period of time. All cooking operations are manually controlled at the present time.

In the initial stages changes were made in the orifice plates

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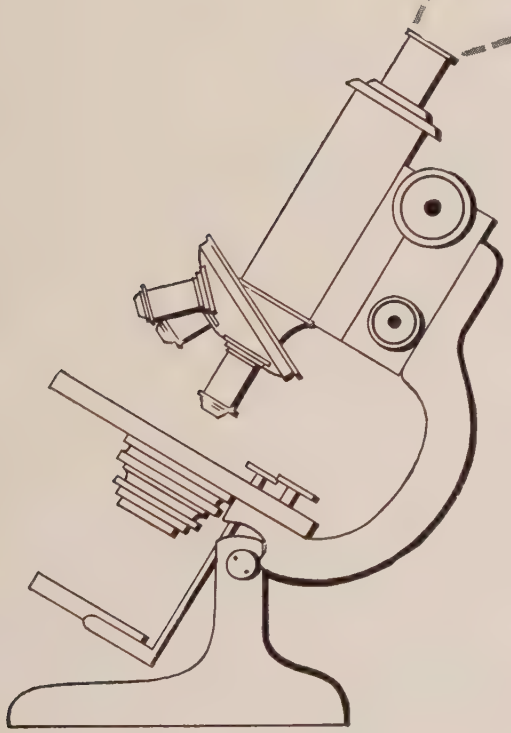
Typical slime-forming organisms



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with other conditions being maintained as near constant as possible. Later changes were made in the total active alkali used and also in total cooking time. After several months of operation in which we observed and evaluated the results of numerous changes in cooking procedure we finally arrived at our present cooking procedure. This procedure is as follows:

In an effort to obtain a uniform pulp in a relatively short cooking period the digesters are brought to full pressure of 98 p.s.i. in 1 hour, the idea being to obtain even liquor distribution by violent agitation. The digester remains at full pressure for 45 minutes and is blown after a total steaming time of 1 hour and 45 minutes.

Table I. Kraft Liquor Requirements

Type of pulp	*Total liquor per AD ton pulp, cu. ft.*	*White liquor per ton, cu. ft.*	*Black liquor per ton, cu. ft.*	*Active alkali per ton, lb.*
Bag paper and linerboard	90–200	80–100	10–110	520–650
High-yield	91	73	18	472

The liquor requirements of a high yield cook are quite different from a cook producing normal yield pulps. Table I shows a comparison between the liquor requirements of a cook for normal yield pulp in the manufacture of linerboard as compared to a high yield cook producing pulp for a similar grade. You will note that the total active alkali amounts to 472 pounds per ton of pulp. The pulp produced from this type of cook has a chlorine number of 13 to 15 and a TAPPI permanganate number of 43 to 46. The spent black liquor as blown has a total solid content of 18 to 20%. Total steam required per digester is 38,500 pounds. A 4300-cubic foot digester cooking in this manner yields approximately 16.5 to 17.0 tons pulp per cook, or 7.5 pounds pulp per cubic foot of digester capacity. Upon refining and screening through 0.125-inch screen plates, a high yield pulp formally produces 4 to 6% rejects. The rejects are sent to a Jackson & Church type ZL press for dewatering, from this point they are returned to the blow tank at a consistency of 38 to 40%.

Remarks by George Whiteside, Container Corp. of America, Fernandina, Fla.

We have four 4300-cubic foot digesters which produce a yield of 14 tons per blow. These digesters are equipped with circulating pumps, but no heaters, and Yarway blow valves. The chip storage is overhead.

The digesters are loaded in 15 minutes with chips and liquor at the same time. The liquor is put in from measuring tanks which have a level recorder and a sight glass. The liquor volume is determined by the chip weight. The active alkali is held constant, even the black liquor active alkali is taken into consideration in the active alkali.

The digesters are steamed on a schedule, one digester every 50 minutes. The steam is added manually at a constant rate about 22,000 pounds per hour. The relief valve on the digester being steamed is kept closed for 50 minutes; at this point the pressure will be 20 to 30 pounds. After the first 50 minutes the relief valve is opened about one-third the way and the temperature pressure relation is brought slowly back to normal. Relieving is manual (2-inch Paul valve). The digester is brought to temperature in 140 minutes (350°F.).

The large steam valves are cut off and a small 2-inch steam valve is used to keep temperatures constant. The temperature is held constant for 110 minutes. At the end of this time the digesters are blown—the digester blowing in 15 minutes.

This schedule provides that two digesters are steaming at the same time thus drawing constant steam flow, only one digester is being relieved heavy at a time and the operations of steaming one digester, cutting steam off another, and opening relief on another are at the same time.

Liquor circulation is to the top and bottom and the suction strainer is one-third the way up the cylindrical side. The majority of the liquor is circulated to the top of the digester.

The digester is provided with a vapor pressure thermometer inserted in a weld at the top of the digester. Pressure is also measured at the top.

The thermometers are rechecked in an oil bath to prevent error, the temperature being the most critical control placed in the operator's hand. It is impossible to overemphasize the difference in the reaction or cooking rate at different temperatures. A rise of 18°F. (approximate) doubles the speed of reaction.

MR. P. B. BORLEW: What kind of wood were you talking about, Mr. Fuller?

MR. FULLER: All different species of wood. Incidentally, on the question of drying by using acetone, you do not need to worry about going back into solution.

MR. BORLEW: You mentioned a chlorine number of 16, Mr. Jones?

MR. JONES: Yes, 14 to 16.

MR. YUNDT: May I make a few additional remarks about permanganate numbers? They are very useful for control purposes because they are quick and simple to make. We at Camp Manufacturing Co. have found that the relation between lignin content and permanganate number is reasonably linear only if less than half the permanganate is consumed. If the Standard TAPPI Method is altered to use 40 ml. of 0.5 *N* permanganate (equivalent to 200 ml. of 0.1 *N*), 40 ml. of 4 *N* sulphuric acid, and the usual quantity of water for 40 ml. of 0.1 *N* permanganate and allowed to react not 5 but rather 15 minutes, then a reasonably linear relationship holds between TAPPI lignin and permanganate number up to about 23% lignin; but only for well-defibered, reasonably uniformly cooked pulps such as would be suitable for putting on the paper machine. Poorly defibered pulps can usually be broken up in a standard Waring blendor. Groundwood gave results about 20% low because of the lower availability and reactivity of its lignin.

Thus the permanganate number test, by suitable alterations, is useful for high yield kraft pulps and even most semichemical pulps. For the former, a lesser time and quantity of oxidant would probably be satisfactory for control.

We find that both speed and accuracy are improved if the pulp in question is made into a handsheet, dried, and a 1.000-gram sample is weighed out in a weighing oven. The dried sample is placed in a Waring blendor with a portion of the test water and 15 seconds suffices for redispersion of the fibers. The remainder of the dilution water is used to wash out the last fibers from the blendor jar into the reaction beaker.

Roughly speaking, within the linear range, the lignin content is equal to one-fifth the permanganate number for most types of pulps. The lignin determination is empirical and so it is to be expected that there would be no exact relationship between two empirical tests. Some part of the lignin is soluble under TAPPI test conditions especially for sulphite pulps, and pure carbohydrate consumes some permanganate, more for the more hydrous forms and more as more permanganate is used. This accounts for the knee in the lignin content permanganate number curve near zero lignin content.

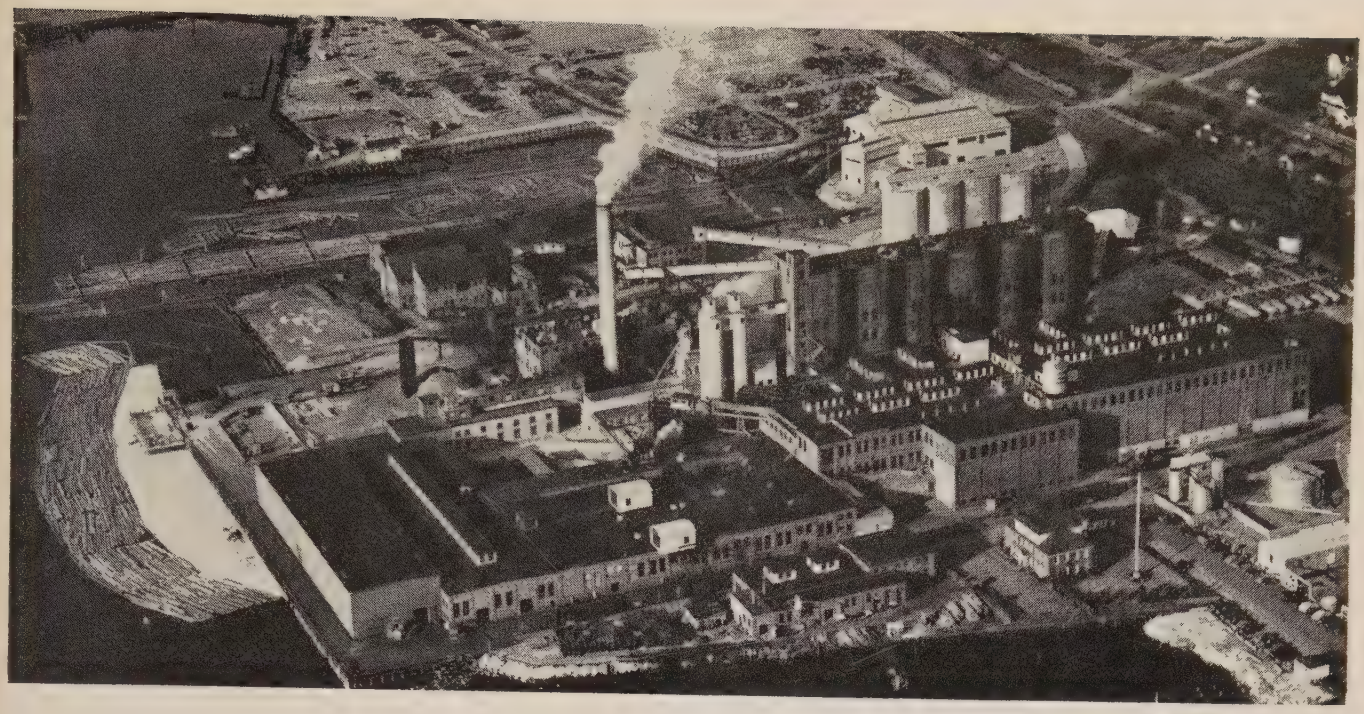
MR. STEVENS: I would like to ask Mr. Limerick was there any correlation between stiffness and yield? As the yield went up did the stiffness also go up?

MR. LIMERICK: No tests were made—I do not know. Gaylord has said that a pulp with 14 to 17% lignin will give maximum stiffness, but I do not know myself.

MR. STEVENS: Years ago, I myself did find an increase in stiffness in corrugating with an increase in yield of pulp.

MR. LIMERICK: Our lignin is about 18 to 19% and this may be approaching the ideal. The yield at this lignin content is between 75 and 80%.

MR. STEVENS: What type of headbox do you have on your machine?



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Mr. Limerick: We have a Walmsley machine with a Voith headbox and produce a smooth glossy sheet.

Mr. Whiteside: How does this 9-point on semichemical compare to the 9-point sheet of high yield kraft?

Mr. Limerick: We now have about double the flatness test compared to the kraft pulp

Mr. Lawrence: I would like to ask Mr. Pineo when he was talking about the alkali liquor to wood ratio, when the liquor ratio was lowered was the yield also lowered?

Mr. Pineo: No.

Mr. Lawrence: You said that by going beyond a sulphidity of 20% that a bleached brightness was easier to achieve?

Mr. Pineo: That is right.

Mr. Sutherland: I omitted one chart in the course of my talk this morning and would like to show it at this time. Figure 2 based on the data of Limerick and Callaghan shows that the effect of high yield pulping is to give an appreciable increase in the hemicellulose and alpha-cellulose and not entirely in lignin as might be supposed. Mr. Pineo's remarks indicate that improved cooking technique through close control of temperature may enable the operator to produce a high yield pulp with easy bleaching characteristics and thus attain higher bleached pulp yields with economically low chlorine consumption.

Mr. Borlew: What is the chlorine number?

Mr. Sutherland: 14 to 16 corresponding to about 19% lignin.

Mr. Jones: I would like to ask Mr. Limerick, were you talking about 9-point board when you stated that your flat crush had been doubled with the installation of your continuous cooking process?

Mr. Limerick: This doubling of the flat crush test was based on corrugating made at a yield of approximately 62%. We have no data on yields less than 62%.

Mr. Whiteside: How much groundwood did you use in your 9-point corrugating sheet when using the high yield kraft?

Mr. Limerick: We ran as high as 40%, but used on the average 20%.

Mr. Whiteside: I would like to ask the assembled persons, how many use effective alkali in cooking instead of active alkali? (Show of hands—one.)

Chairman Fuller: This concludes the meeting for today. I would like to thank all for their wonderful cooperation at this meeting.

Friday, Sept. 28, 1951

Friday morning, busses took most of the group to the mill of the Chesapeake Corp. of Virginia at West Point, Va. Guides were provided who took the men all over the plant explaining the various phases of their operations. After the visit everyone went to the Williamsburg Inn at Williamsburg, Va., where, with their wives, they were guests of the Sutherland Refiner Corp. for refreshments and luncheon. A tour of Colonial Williamsburg completed the day.

Arrangements for the meeting were made by Henry Vranian, Chesapeake Corp. of Virginia; R. R. Fuller, Gulf States Paper Corp.; A. P. Yundt, Camp Manufacturing Co., Inc.; G. R. Tennant, Hummel-Ross Div., Continental Can Co.; and M. G. Selden, Albemarle Paper Mfg. Co. They were ably assisted by the other members of the TAPPI Alkaline Pulping Committee.

The cooperation of the local advisory committee consisting of M. C. McDonald, Chesapeake Corp. of Virginia; Hugh D. Camp, Camp Manufacturing Co.; F. D. Gottwald, Albemarle Paper Mfg. Co.; and E. H. Graves, Continental Can Co., did much to make the conference a success.

Mrs. K. F. Adams, Mrs. S. Douglas Fleet, Mrs. E. H. Graves, Mrs. John Priest, Mrs. J. A. Staidl, and Mrs. Erik Zimmerman were the Ladies Entertainment Committee.

Sixth Engineering Conference

The Sixth Engineering Conference sponsored by the Technical Association of the Pulp and Paper Industry was held at the General Oglethorpe Hotel, Savannah, Ga., Oct. 15–18, 1951. About 750 men were in attendance and included representatives from all over the United States, Canada, and several European countries.

The conference was opened at 9:30 a.m. in the Crystal Ballroom of the hotel with a few words of greeting from G. W. E. Nicholson of the Union Bag & Paper Corp., Charles S. Heustis, Southern Paperboard Corp., and Reavis C. Sproull of the Herty Foundation Laboratory.

The first session was assigned to the Engineering Research and Machine Design Committee and Robert A. Nivison, Improved Paper Machinery Co., Nashua, N. H., gave a paper "Capacity of Thickeners."

This was followed by the Data Sheets Session. Henry J. Perry, *Paper Trade Journal*, Chairman of the Data Sheet Committee and R. T. Bingham, TAPPI, discussed the data sheet problem.

The Technical Association issued its first Data Sheets in 1939 with the intention of adding to them on a yearly basis to the end that eventually they would constitute a pulp and paper industry engineering handbook. The Data Sheet Committee is well organized and has a system that appears to be well adapted for the screening of suggested material. It has been hoped that committees and individuals would provide acceptable data, however, results have been disappointing. A plea was made for better cooperation if the Data Sheet service is to develop into the source of information that was intended.

Several of the committees of the Engineering Division had luncheons at which the plans for the coming year were discussed.

The Mill Design and Economic Aspects Session was first on the program, the chairman being Roland A. Packard, Consulting Engineer.

Parkman A. Collins and J. G. Rearick of the Warren Steam Pump Co., Warren, Mass., presented a paper "Pump Difficulties in Pulp and Paper Mills."

The varied kinds of paper and the special furnishes to make them have created special pump problems. These are apart from the familiar entrained air difficulties and have to do with gaseous conditions. They appear to be related to vapor pressure considerations such as we apply to condensate work. There are not sufficient data available as yet, however, for intelligent calculations. Such calculations are precise in the case of boiler feed and condensate work and it is believed the

The registration desk at the Sixth Engineering Conference held in Savannah, Ga.

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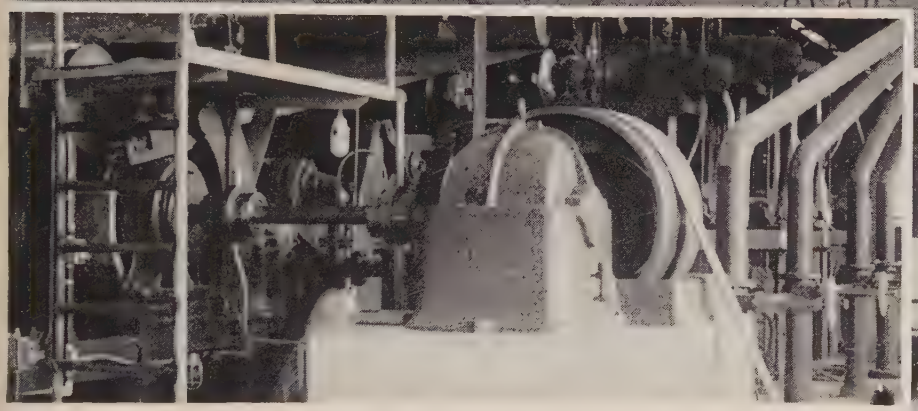

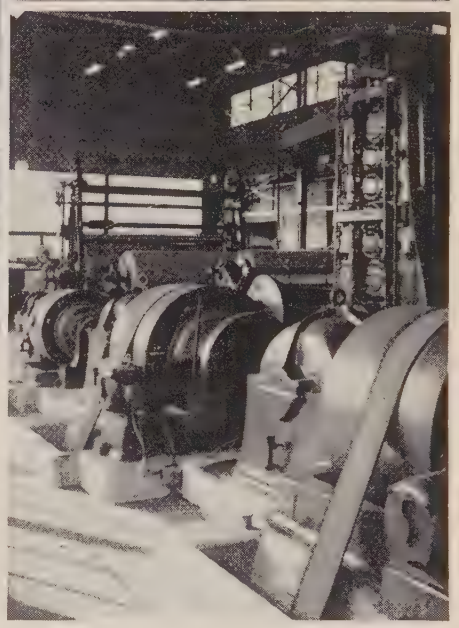

By today's standards a paper machine drive has to be of the right materials, compact, totally enclosed.

It has to be a precision mechanism, with all operating parts in perfect balance to assure smooth, vibrationless operation.

It has to have a lubrication means that requires the minimum of attention—automatic oiling of gears and bearings.

It has to be rugged enough and dependable enough to operate twenty-four hours a day for days on end without attention.

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Meeting group at the Sixth Engineering Conference, General Oglethorpe Hotel, Savannah, Ga.

same factors could be applied if we knew more about the physical properties of these stocks with respect to vapor pressure and surface tension. This would enable us to make more exact recommendations regarding suction head and recirculation so as to keep pump suction chamber clear of gas and not block the passage of stock to impeller inlet.

Exploration of this field can be forgotten when someone designs suitable apparatus for removing air from stock in this area of the pump. This appears difficult yet not impossible. When accomplished it will make centrifugals completely reliable even though they may be set far from chests with unfavorable suction connections and handling gaseous stocks. The same principle would automatically take care of the nuisance problem of excessive entrained air encountered quite frequently on ordinary furnishes and which we now solve by good pump designs and by paying special attention to layout in cooperation with the mill.

The next paper "Mill Engineers Selection of a Paper Machine Drive—Part II" was given by A. N. Ball of The E. B. Eddy Co., Hull, Que.

The first paper, Part I, of this study was given by Roland Packard at the Fourth Engineering Conference in 1949 and was followed by an interim report last year in Cincinnati. In continuing this investigation a large number of questionnaires were sent out to which 25% of the companies solicited responded.

A drive will be required to fulfill the following functions reliably, consistently, and, from the operator's point of view, simply:

1. Maintain an over-all machine speed within the limitations of the machine, as selected by the operator.
2. Provide means of accelerating and decelerating each section of the machine, and when necessary, a prolonged slow crawl for any section, as well as inching.
3. Rapid and accurate draw adjustment for individual sections. Also, adjustment of the wet end section should automatically adjust all forward units, whereas adjustment of the dry end section should automatically adjust all preceding units.
4. Momentary speed changes in any section to take up slack.
5. Facilities for reversing the calender stack are very desirable when running many grades of paper where plugging is somewhat prevalent:

For clarification and simplicity of approach the various types of drives have been divided into four main divisions, as follows: (1) sectional electric drives, (2) single motor electric drives, (3) direct connected turbine drives, and (4) hydraulic variable speed drives. These are discussed.

In studying the various points of the general survey, the following points stand out clearly:

1. For machine speeds of over 1000 f.p.m., the rapidity of adjustment and accuracy of speed regulation indicate a definite advantage in favor of the sectional electrical drive.
2. A well-maintained single motor electric drive is an extremely satisfactory drive, and answers all the requirements at speed of less than 1000 f.p.m. with the exception that an adjustment of the wet end section will not automatically adjust all preceding units.
3. Crawling can be accomplished with both systems with helper motors. With narrow, reasonably slow machined (around 750 f.p.m.) the drum-type clutch will permit crawling of the driers for a fair length of time. For speeds in excess of 750 f.p.m. it is advisable to slow down the driers during crawling operations to save the burning of and the resultant high maintenance on clutches.

The meeting then broke up into three discussion sessions.

John D. Lyall, Armstrong Cork Co., Chairman of the Engineering Research and Design Committee, introduced L. A. Moore of the American Coating Mills who gave a subcommittee report on centralized control of stock systems.

In his discussion "Measuring the Density of Rubber Covered Paper Mill Rolls" Ralph M. Leighton of Stowe-Woodward, Inc., Newton Upper Falls, Mass., mentioned that there are in use three instruments for testing rubber-covered rolls—Shore Type "A" Durometer, Adams Densimeter, and the Pusey & Jones Plastometer. Readings were taken using these three instruments and compared with the values given in the Vanderbilt Handbook, 1941.

There is no over-all comparison and correlation of the three measuring instruments. A comparison can only be made within the same stock. This can be done by plotting curves for each individual stock in use. Even by this method, we can expect as high as 5 points' variation between the given Durometer and Plastometer readings. This is logical since the Durometer and Densimeter are spring instruments, and by their nature cannot be accurate as compared to the Plastometer. It seems that the optimum and most accurate readings would be the Plastometer, taken at the end of a minute exclusively, thereby eliminating the necessity of comparison.

Following this H. G. Ingraham, Chas. T. Main, Inc., Boston, Mass., presented a subcommittee report on methods of estimating costs of engineering projects and consideration of cost indices.

During a meeting of the Engineering Research and Machine Design Committee which was held last year at Cincinnati, it was proposed that methods be established to assist in the estimation of engineering costs.

It is the belief of the committee that some information on preliminary cost estimation can be obtained but it will be necessary to decide upon a system for keeping it up to date. Discussions on this subject were invited by the committee.

In the Chemical Engineering Committee discussion session, J. R. Lientz, Union Bag & Paper Corp., reported on the committee's survey on digester corrosion.

In the third group, the Mill Design and Economic Aspects Committee had a panel discussion of the problems involving air and water removal at the wet end of a paper machine. This was led by C. L. Clark, Clark & Vicaro, Bronxville, N. Y. On the panel were: A. W. Redlin, Beach & Arthur Paper Co., Modina, Pa.; T. E. Ramsay, Ecusta Paper Corp., Pisgah Forest, N. C.; J. Ward, Union Bag & Paper Corp., Savannah, Ga.; E. H. Niederauer, Escanaba Paper Co., Escanaba, Mich.; S. H. Grimnes, Diamond Match Co., Plattsburg, N. Y.; and A. J. Karpinsky, Scott Paper Co., Chester, Pa.

Tuesday, Oct. 16, 1951

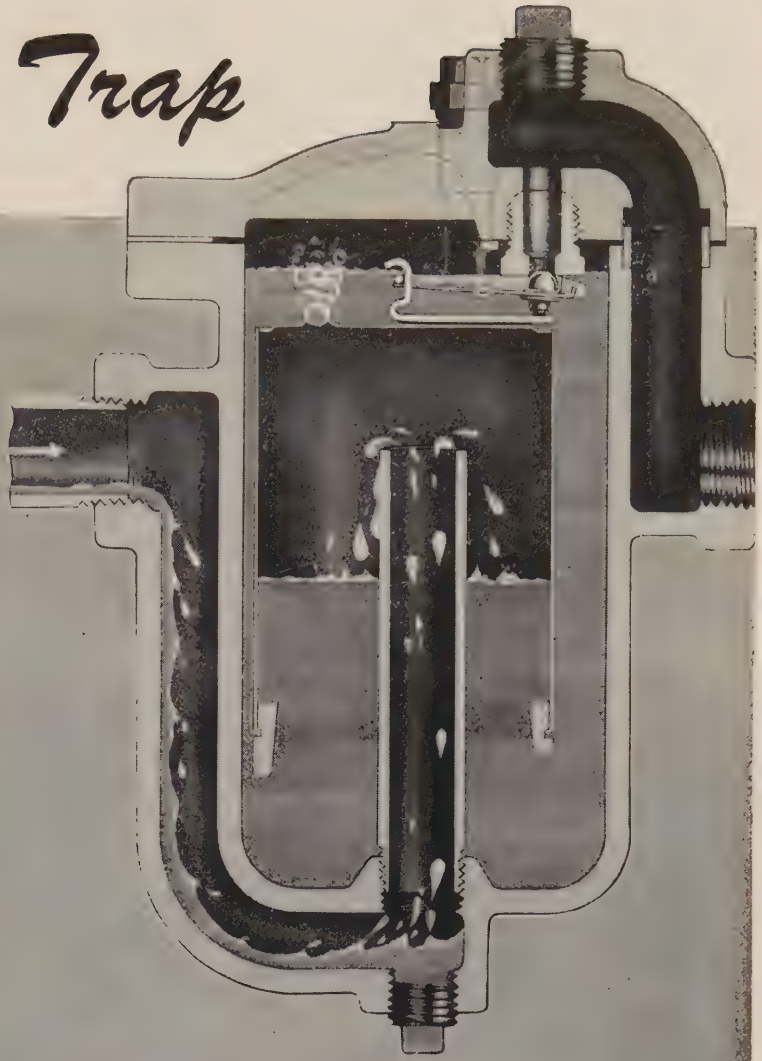
The day started with a breakfast at which the chairmen and the secretaries of the various committees met with Henry Perry to discuss the TAPPI Data Sheets.

The formal program, however, was led off by K. J. Mackenzie, Eastman Kodak Co., Rochester, N. Y., Chairman of the Hydraulics Committee. He introduced Victor P. Head of the Fischer & Porter Co., Hatboro, Pa., who presented a paper "A Shear Criterion for the Hydraulic Behavior of Paper Stocks in Pumps, Pipes, Valves, and Flow Meters."

Apparent viscosity of a non-Newtonian fluid is not a fluid property, nor does it have meaningful physical dimensions in mass-length time in the absence of completely defined flow geometry. The slope and intercept of the shear diagram are truly fluid properties which remain constant over wide ranges

This Steam Trap

MEETS THE REQUIREMENTS of Paper Machine Drainage



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Engineering Division and Committee Chairmen and Secretaries

of shear rate and which have the physical dimensions of viscosity and of stress, respectively. The terms slope viscosity and apparent yield stress are proposed as descriptive of these properties. If found acceptable, the word slope might ultimately be dropped when sufficient familiarity with the concept has eliminated the confusion with "apparent viscosity" which would certainly exist at present. The definition of viscosity might then be altered to mean the slope of the shear diagram in all cases, while the difference between true and non-Newtonian fluids would be expressed merely by the value of the apparent yield stress, which is, of course, zero for Newtonian fluids. Slope viscosity assumes a negligible role and yield stress in shear a dominant role in the case of paper stock flow in pipes, pumps, valves, and flowmeters. A shear criterion has permitted very precise correlation of the flow coefficients of variable-area flowmeters in stock service, and a fiber-length criterion has provided an easy method of expressing the limits of validity of the shear criterion. The shear-theory of the flowmeter has been extended to illustrate the possibility of a variable-area consistency meter. Promise of equal success in the case of pipe friction appears evident, and it is hoped that the yield-stress concept will prove useful in many other phases of paper engineering.

The next paper was "An Analysis of Data on Stock Flow in Pipes," by Richard A. Durst, Andrew J. Chase, and Lyle C. Jenness of the University of Maine.

A mathematical analysis of the head loss due to pipe friction in transporting pulp stock suspensions has been made of three of the major sets of data published; the Brecht and Heller the Forrest and Grierson, and the Cameron data. Other data were not used due either to their unavailability or the lack of time to study them.

The correlations proposed by two earlier workers were studied. The Cooper correlation defined on apparent viscosity which was evaluated by the equation, $\log \mu = \log 0.095DC^3 - 0.05u$. The Peterson correlation introduced a pseudo-Reynolds No. having the dimensions $V\rho_1/S$ where S = consistency.

The proposed correlation based on the Brecht and Heller data for unbleached sulphite pulp uses a plot of a friction factor versus a pseudo-Reynolds No. (Re′ No.) defined by the following equation;

$$\frac{\Delta H_f D}{u^2 L} = f = \phi \frac{D^{0.205} u}{C^{1.157}}$$

This relationship holds for the Brecht and Heller data within ±7% for all consistencies, and for velocities below a value in feet per second equal to the consistency raised to the 1.2 power.

The corresponding correlation for the Forrest and Grierson data for sulphite pulp has a Re′ No. $u\rho/D^{0.4}C^{1.87}$, and for groundwood the Re′ No. is $D^{0.15}u\rho/C^{1.385}$. Both these relationships hold within ±25% for all pipe diameters, consistencies, and velocities presented in the data.

The Cameron data gave a correlation with a Re′ No. $D^{0.01}u\rho/C^{2.52}$ for groundwood. The relationship is good within ±30% exclusive of consistencies below 1.8% b.d. stock. For these low consistencies the correlation deviated progressively up to +100% as the consistency decreased from 1.8 to 1.5% and the velocity increased from 4 to 16 f.p.s., and the pipe diameter increased from 6 to 16 inches.

The effect of the type of stock on head loss may be illustrated by referring to a further analysis of the Brecht and Heller data. Referred to unbleached sulphite stock as the standard, the head loss may be predicted for the following stocks within the limits indicated by correcting the calculated head loss for unbleached sulphite stock by the percentages indicated;

Stock	*Re′ No. range*	*Deviation from sulphite, %*	*Expected % deviation*
Unbleached sulphite	8– 80	0	± 7
Bleached sulphite	16– 64	−12	+ 5
Unbleached straw	16– 40	−55	±11
Bleached straw	16– 40	−10	± 1
Groundwood	16– 64	+42	± 6
Cooked groundwood	16– 64	0	± 6
Sulphate	16–100	−10	±15

The Brecht and Heller correlation showed the highest order of consistency within a single body of data using the proposed analysis. Based upon this observation the data of Forrest and Grierson and Cameron were correlated using the Brecht and Heller Re′ No. The result was a family of nearly parallel curves relating the friction factor and Re′ No. Working from this chart the head loss may be predicted within the limits indicated:

Data group	*Re′ No. range*	*% deviation*
Brecht and Heller, unbleached sulphite	8– 80	± 7
Forrest and Grierson, sulphite	6–120	±25
Forrest and Grierson, groundwood	10–150	±25
Cameron, groundwood	20–200	±50

The Brecht and Heller data relating freeness to head loss showed that freeness has less effect than the deviation of ±7% in the proposed correlation. A correction for freeness therefore, does not seem feasible at this time. Also within the range of 18 to 35°C., temperature does not affect the head loss beyond the accuracy of the correlation.

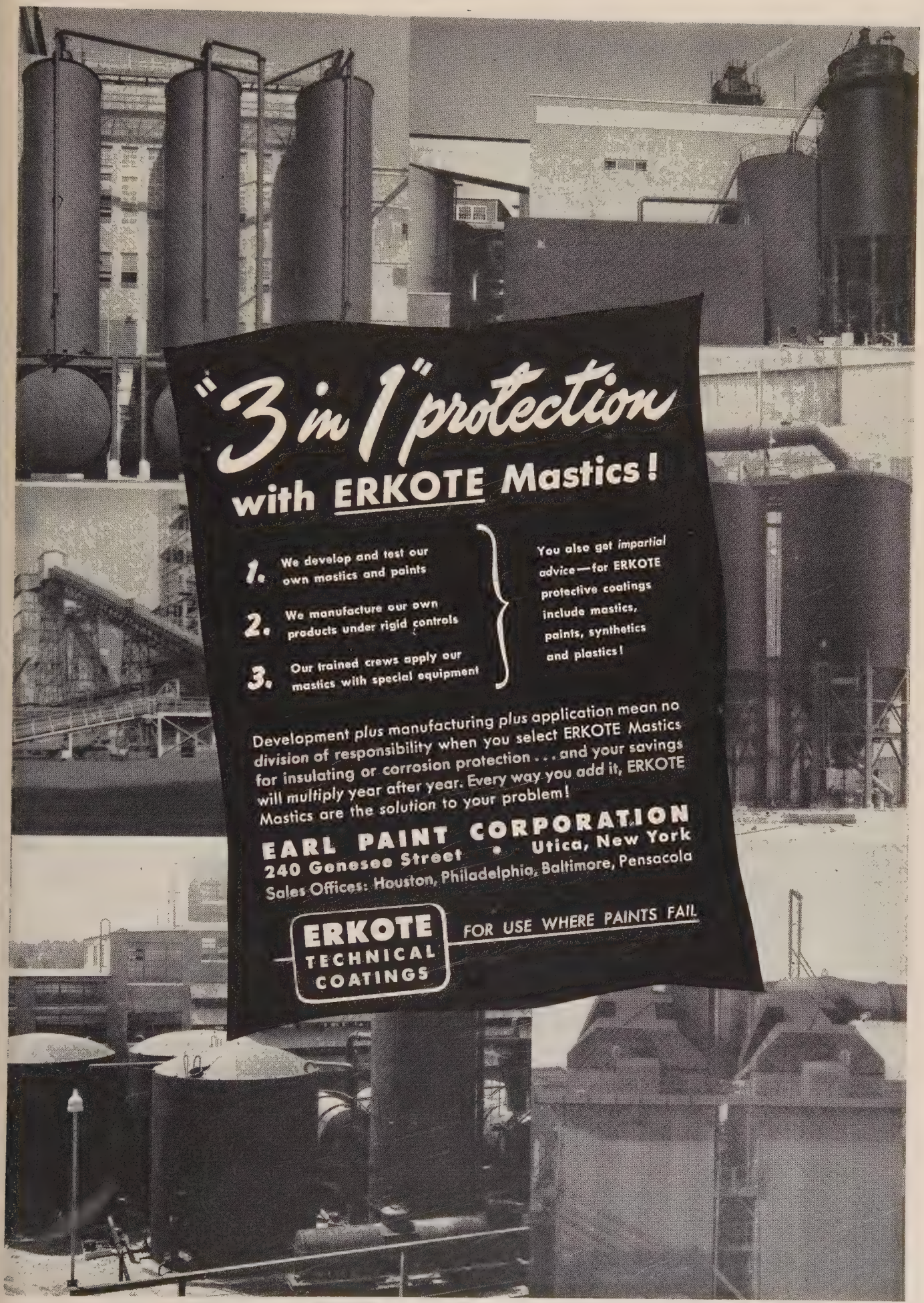
The Steam and Power Session followed with C. J. Sibler, West Virginia Pulp & Paper Co., as chairman.

The first paper was given by E. A. Kerbey, Midwest Piping & Supply Co., St. Louis, Mo., "Materials and Design of Piping Systems for High-Pressure and High-Temperature Service."

Until several years ago, the highest temperatures encountered in paper mill steam piping were 700 to 750°F. close to but not impinging upon the upper limits for carbon steel material. With plans for operations at 900°F. with 1200 p.s.i., an entirely different condition, high pressure, and temperature service needs be reconsidered. This is especially important because of the constant changing of code requirements

One of the first considerations in the design of piping is the selection of the proper grade of steel. In this three factors must be held in mind: the performance under the expected operating conditions; its workability in bending, lapping, forming, and welding; and its availability. These are to be discussed.

Increased temperatures operate in two ways to present the piping designer with more difficult problems of expansion and flexibility. In the first place, greater temperatures obviously mean greater expansion; hence in a high-temperature steam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Engineering Luncheon Head Table. Left to right: H. R. Arnold, Riegel-Carolina Corp.; W. C. Bloomquist, General Electric Co.; H. F. Parker, New York & Pennsylvania Co.; M. L. Barker, Beckett Paper Co.; and Douglas Jones, Canadian Pulp & Paper Association

line, which may expand as much as 9 inches per hundred feet, flexibility becomes a very serious consideration. On the other hand, allowable working stresses must be reduced as temperatures rise; this requires greater pipe wall thicknesses which in turn tend to reduce the flexibility of the system. The net result of these two effects is to compound the problem of flexibility so that the designer must give increasing attention to the means of accommodating pipe expansions—not only to prevent the steam line from exerting excessive reaction on the equipment it connects. In many cases, the manufacturers of turbines and other equipment now specify maximum permissible thrust at connections, and some ask that the piping layouts be submitted for flexibility analysis by their own engineers.

In the design of hanger, anchors, and supports, the same degree of engineering judgment and skill is required as for the design of the piping itself.

This limited analysis was intended to do no more than to outline some of the problems involved in high-temperature pressure piping systems, and to emphasize a thread of thought which inevitably must be woven through any discussion of this topic: that at temperatures above 750°F. every aspect of the piping problem—design, fabrication, and erection—becomes more exacting in its demand for special knowledge, special skill, and special equipment.

W. B. Wilson and W. C. Bloomquist of the General Electric Co. presented the last paper on the morning's program, "Combustion Gas Turbine Applications in the Paper Mill."

The gas turbine is well suited where both electric power and process steam are required as they are in the paper industry. The various gas turbines available for paper mill applications were described. Slides were used to show various cycle arrangements where gas turbine exhaust gases are used to generate steam in waste heat boilers, to supply combustion air for fuel-fired boilers, and for other exhaust-heat recovery applications.

The gas turbine is well suited for mill expansions or for new mills. Examples and curves were used to indicate how the gas turbine can be used, either alone or in conjunction with steam turbines, to supply the mill's steam and electrical requirements at high over-all power plant efficiency.

As with the preceding day's luncheon period, the rest of the committees took advantage of an opportunity to meet together to discuss future plans.

The first part of the afternoon was devoted to the Electrical Engineering Session, R. W. Foster, Champion Paper & Fibre Co., Canton, N. C., Chairman. First on the program was "The Power Requirements of Fourdrinier Sections" by G. W. Mikelson, General Electric Co., Schenectady, N. Y.

Several modern machines have been studied to determine how power is distributed throughout the fourdrinier elements to provide a basis for the re-evaluation of existing power constants used to calculate and predict power requirements on new machines. A more accurate procedure has been derived.

A. O. Mortenson, St. Regis Paper Co., followed with a progress report on electric cable investigation. This was a progress report that treated the purpose of the investigation, outlined accomplishments to date, suggested work for the future, and pointed the way toward what is best to use for the various services in all departments of each and every branch of the pulp and paper industry. Briefly, the investigation is being conducted for the purpose of establishing power cable specification standards from what is best in the field today. And, the many North American mills and others, including the cable manufacturers, who have cooperated and are cooperating in this effort have demonstrated the necessity and the urgency for this progressive step.

Conditions peculiar to each department were considered. Methods of installation were also taken into account, as were common causes of cable failure and the predominant location of those failures.

The data obtained were brought together in chart form for presentation as part of this report.

While much work remains to be done and specifications have yet to be written it is felt that much of interest and value has been gathered together.

The last paper was "Properties of Synthetic Rubber and Thermoplastics as Insulation and Sheets on Electric Cables," by E. W. Davis, Simplex Wire & Cable Co., Cambridge, Mass.

As a result of chemical research and technological developments during and subsequent to World War II, there has become available to electrical engineers concerned with the distribution and utilization of electrical energy, a new field of electrical insulating materials and protective sheath coverings that offers a wide range of electrical, chemical, and physical properties consistent with longer life expectancy than thought possible less than a decade ago when the use of natural rubber was almost universal in rubber compounds used in the manufacture of electric cables.

The essential properties of an insulating and sheath compound for an electric cable depend primarily on the service conditions including operating voltage, current load, system characteristics, temperature of surroundings, exposure to heat, light, and moisture—and for cables used in the pulp and paper industry, exposure to many chemical solutions not generally found in other industries.

Replies to a recent questionnaire prepared by the TAPPI subcommittee on cables and sent to all of the operating plants of the pulp and paper industry showed that the predominant causes of cable failures have been as follows:

1. Deterioration due to age and oxidation.
2. Deterioration due to exposure to oil, water, sunlight, and chemicals.
3. Improper termination and splicing.
4. Damage to cable during installation.

There was a considerable spread between the assigned causes of the cable failures as reported by the plants employing various processes of pulp treatment (sulphite, sulphate, groundwood, rag, etc.) but there was a definite pattern which assigned the four causes listed above as being predominantly important.

The paper presented pointed out how, by employing some of the synthetic rubbers and thermoplastics available today, the wire and cable failures due to the first two causes listed above can be considerably reduced. Comparison of the properties of the synthetic rubber compounds with those employing natural rubbers as a base will be presented. No attempt was made to discredit natural rubber compounds for use in electric cables, but rather the better essential properties of the synthetic rubbers for this purpose were pointed out.

The remainder of the day was devoted to discussion ses-

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Engineering Luncheon Head Table. Left to right: J. R. Lientz, Union Bag & Paper Corp.; R. W. Foster, Champion Paper & Fibre Co.; H. J. Perry, Paper Trade Journal; *K. W. Mackenzie, Eastman Kodak Co.; and J. D. Lyall, Armstrong Cork Co.*

sions. In the Electrical Engineering Committee meeting, R. R. Baker, Westinghouse Electric Corp., gave a "Preliminary Report on Power Requirements for Press Sections of Paper Machines" and in the Hydraulics Committee, K. J. Mackenzie led a discussion on the papers presented in the forenoon.

At the Steam and Power Committee meeting, G. W. Bollinger, West Virginia Pulp & Paper Co., Charleston, S. C., with W. C. Bubar; Bubar Dust Systems, Inc., R. Ellwanger, Chesapeake Corp. of Virginia, C. A. Gallay, Buell Engineering Co., and C. C. Bush, Union Bag & Paper Corp., discussed cinder collection.

In discussing cinder collection the following points were discussed: various types of collectors, installed and operational costs, air pollution, bark burning unit (cinder collection), and how furnace and burning equipment design affects carryover of fly ash from bark burning units.

There was also a paper "Education of Power Plant Engineers" by M. F. Schnaufer, Detroit Sulphite Pulp & Paper Co. Managements of most pulp and paper mills are confronted with the complex problem of how to train new power plant personnel and to bring old personnel up to date in the operation of complicated power equipment. To be successful a program must be well planned and managed as a long-term investment acceptable to both management as well as to the employees and their union.

To provide a basis for discussion the curriculum offered by the Dow Chemical Co. for their power plant engineers was outlined.

In the evening there was a get-together party and dinner on the General Oglethorpe grounds which was sponsored by the Allied Industries.

Wednesday, Oct. 17, 1951

At the opening session devoted to Drying and Ventilating, Marshall L. Barker, Beckett Paper Co., Hamilton, Ohio, the chairman, first introduced Charles P. Spaulding, Beloit Iron Works, Beloit, Wis., who presented a paper "High-Pressure Driers." He was followed by L. G. Janett, J. O. Ross Engineering Co., New York, N. Y., with "Ventilating for Comfort of Personnel."

Correlating the studies that have been made in so-called "hot" industries such as underground mining, the steel, and the aluminum industries, a preliminary set of thermal standards for industry have been recently set forth by a committee of the American Public Health Association. Included in these studies are laboratory and Army experiments on the maximum continuous high temperatures that can be tolerated by humans under varying working or metabolism rates. A preliminary standard has been set forth, subject to change, that considers a temperature to be safe at which operators can work continuously provided that their pulse rate remains under 125 and their body temperature remains below 101°F. These standard were presented in table form.

Paper machine room conditions were compared with these standards and factors of worker comfort and morale were discussed together with the effect of high temperatures on worker and production efficiency.

"Effective" temperature as a composite temperature combining dry bulb temperature, wet bulb temperature, air velocity, and radiation factors was explained to show that the old saw "It isn't the heat, it's the humidity" is true in principle.

The engineering aspects and measures to improve the temperatures in the operating areas were outlined. These include standard hoods, complete insulated enclosures of paper drier sections, air exhaust systems, and air supply cooling systems.

The effect of radiation from paper machines, walls, and building elements was discussed together with a method of evaluating a "mean radiant temperature" by means of a special globe thermometer.

High-speed fourdriniers operating with elevated water temperatures resulting in high wet end humidities were described with some remedies that can be applied.

Opposing the means to achieve comfort are the factors which keep production or drying capacity high, namely high drier pressure and temperature together with high ambient air temperatures surrounding the paper machine.

Short of expending exorbitant sums to achieve both a high degree of comfort and high production capacity it is desirable to achieve such operating conditions representing a fairly optimum middle ground that will essentially satisfy the psychological, physiological, and production problems that are involved.

The chairman of the Materials Handling Session was W. R. McNally, Link-Belt Co., Chicago, Ill., the secretary of the committee acting for the chairman, A. P. Schnyder of Ebasco Services, who was not able to attend the conference.

The first paper "Woodmill Log Handling in the Pulp and Paper Industry on the West Coast" by W. H. Rambo and H. A. DeRice, W. H. Rambo, Industrial Plant Engineers, Portland, Ore.

This paper gave and illustrated, by means of twenty-eight slides, the most modern and up-to-date log-handling devices in woodmills on the West Coast. Illustrated and described were the most modern log hauls, log transfers, roll conveyors, log loading and handling equipment, and band mill installations.

The paper also illustrated and touched on hydraulic barking and chipping of whole logs and small wood handling.

The paper throughout dealt with actual new installations, some of which have never been published before, which are operating profitably every day.

Next was "Wood Handling Methods in Pulp Mills of Eastern North Carolina and Virginia," by C. L. Wills and C. L. Hildebrand, Halifax Paper Co., Roanoke Rapids, N. C.

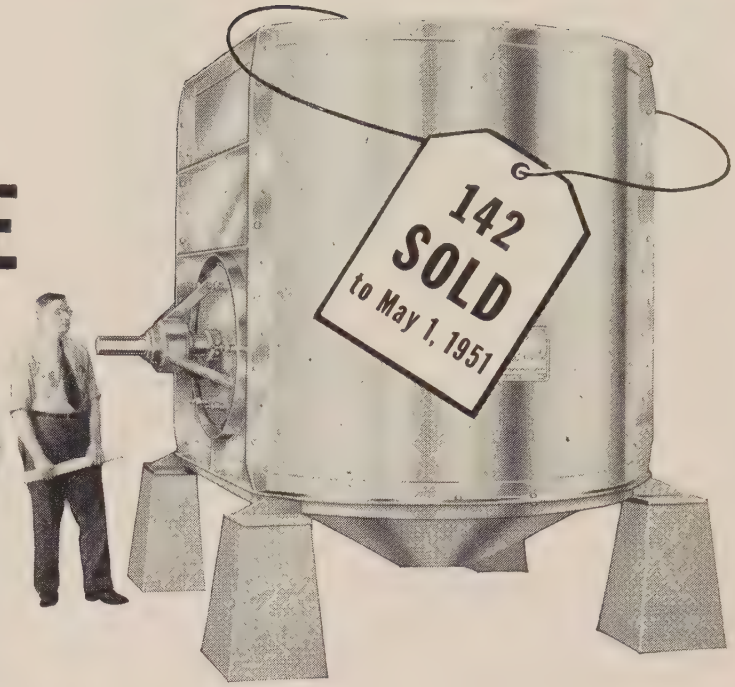
This paper described methods of handling and storing pulpwood in pulp mills in Eastern North Carolina and Eastern Virginia with special emphasis given the modernizing of the wood yard of the authors' company.

The system of storing pulpwood in 5-foot lengths jackstraw style in long piles parallel to a conveyor and handling by crane was decided on in 1946. Previous to this, wood was ranked 8 feet high all over the yard and moved by trucks and manual labor. A short conveyor for receiving wood from incoming trucks and a parallel rail sliding close by delivered wood to the barking drum. Capacity of the system was inadequate and operating cost excessive.

In the modernization, the barking drum and old conveyor were left intact and a new loading conveyor, 520 feet long in two flights, was built 200 feet away from and parallel to the old, with a 200-foot long transfer conveyor delivering wood

E.D. Jones

ACCEPTANCE



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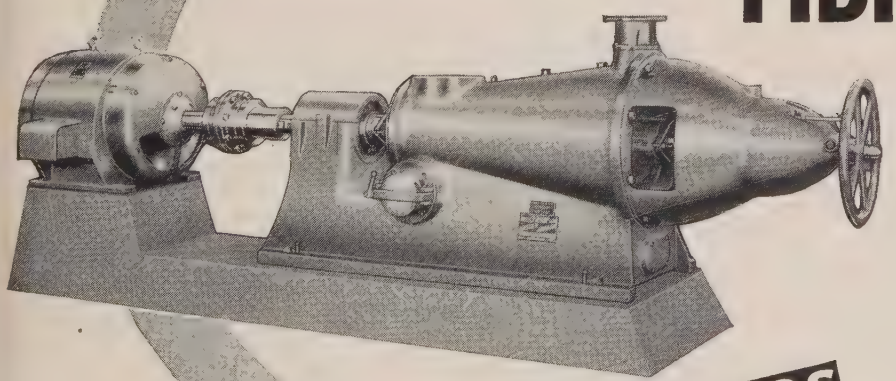

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BUILDERS OF QUALITY STOCK PREPARATION MACHINERY

Engineering Luncheon Head Table. Left to right: C. J. Sibler, West Virginia Pulp & Paper Co.; K. O. Elderkin, Crossett Lumber Co.; R. P. Price, Hammermill Paper Co.; R. G. Macdonald, TAPPI; J. W. Hemphill, Johns-Manville Co.; and G. W. E. Nicholson, Union Bag & Paper Corp.

from the new loading conveyor to the drum. Two 2-yard crawler cranes with 80-foot booms were purchased, one with an orange peel pulpwood grapple and one with a hook.

Some changes after initial construction were required at the transfer points to eliminate jams.

The storage piles are filled and emptied in rotation which gives a uniform storage period to all wood and makes possible an easy method of taking inventory. Generally, wood received by rail, which is 35% of the total receipts, goes directly into the mill while truck receipts go into storage.

The old wood yard required 1.95 man-hours per cord of wood consumed at maximum capacity of 250 cords per day. The new installation requires 0.48 man-hour per cord of consumption handling 450 cords per day, and could handle more units with the same man power.

In one mill is a successful installation of log conveyors using rubber-covered canvas belts instead of chains. The same mill uses a large gantry crane to unload trucks by sling and reclaim from storage with a grapple. They also receive wood by barges, unloading into conveyors with stationary derricks. At the loading points of the conveyors are special hoppers for feeding the conveyors.

Another mill handling 1500 cords per day has an elaborate sorting table after two barking drums. They use two locomotive cranes for putting wood into and out of storage.

The final paper was given by H. A. Stoess, Jr., The Fuller Co., Catasauqua, Pa., "Pneumatic Conveyors in Pulp and Paper Mills." Pneumatic conveyors are used in pulp and paper mills for the conveying of wood chips, and the unloading from cars to storage bins and reclaiming from storage bins to use bins, of bulk chemicals. Their advantages include freedom from dust, low handling loss or shrinkage, and, good labor relations, while their disadvantages, although comprehensive, include higher power cost, higher capital investment, and unidirectional. In comparison with other types of conveyors for the same basic requirements, these disadvantages are, for the most part, tenable.

The most common and practical use of a pneumatic conveyor in chip conveying is the transfer of chips from the wood room to the chip loft, or bins, above the digesters.

For the unloading of bulk chemicals, the vacuum type of system is always used. This type of system unloads both hopper bottom and box cars with a minimum of labor and dust loss. The system terminates in a bag type of filter above the storage bin giving a 100% visible retention of dust. For distribution to two or more bins, either gravity spouts, if acceptable or practical, or, mechanical conveyors are used.

For reclaiming, both the vacuum and pressure types of systems are used, with the majority of installations favoring the vacuum type. Certain methods of reclaiming from storage bins are used, with each method being governed by the physical characteristics of each chemical being conveyed.

In recommending pneumatic conveyors, it must be borne in mind, that there is a place for this type, and, a place for other types. The final decision is based upon the economics of the installations, including the amount of labor involved, and, the maintenance to be expected.

Engineering Division Luncheon

The Engineering Division Luncheon was held Wednesday noon. G. H. Pringle, of the Mead Corp., Chillicothe, Ohio, immediate past general chairman, and Vice-President of TAPPI, was master of ceremonies at the luncheon, which was attended by approximately 550 delegates.

K. P. Geohegan, President of TAPPI, congratulated the members of the Engineering Division, who are meeting in the South for the first time, for the expansion of their TAPPI program in recent years.

Dr. Nink Blok of the Van Gelder Zonen Royal Paper Mills, Amsterdam, Netherlands, expressed his appreciation to the Association for their cooperation in rebuilding the paper industry in the Netherlands in the postwar years. His remarks follow:

It is a great honor to me to attend this 6th annual Conference as a representative of the Van Gelder Zonen Royal Paper Mills of Amsterdam.

C. Beuker, President of our Company, intended to be present here also, but unfortunately he was forced, much to his regret, to give up this plan at the eleventh hour for circumstances of business nature. He would have liked to make use of this opportunity to express the thanks of the board of directors of Van Gelder Zonen to the Technical Association of the Pulp and Paper Industry and to the American colleagues for the great hospitality and the very extensive technical information extended to him personally and to the members of the staff of Van Gelder Zonen, during their visits to the States in the years after the war.

The enemy occupation of the Netherlands, which has lasted five years, and the terrific destruction of our mills during the war have resulted in our dropping behind in production. It was impossible for us during those years to obtain any information about the progress made in America of technical and chemical nature.

What we have seen in the States in the postwar years has impressed us considerably and has convinced us that the occupied European countries have fallen behind very badly, both in the chemical and the technical field and that they have much ground to make up. It would have been possible to do so more quickly, if only most of the European countries had not been impoverished considerably on account of the war. They have no dollars at their disposal to buy up-to-date American machines.

Nevertheless we have taken advantage of our American journeys by putting into practice as successfully as possible the improvements we have seen at our American colleagues.

When, one day, our joint wish, The United States of Europe, has been realized, when there will be one large outlet, we shall be able in Europe to work with larger units exactly as in your country, which will improve the economy and the standard of living considerably. A high standard of living is a guarantee for world peace. Social security stimulates devotion to duty and greater zest for work. By understanding each others' difficulties and mutual assistance we build a better world.

In the work of TAPPI I see the realization of these thoughts.

For the actual assistance which Van Gelder Zonen has always received from TAPPI the board of directors of Van Gelder Zonen wants to thank you most sincerely and in their name I should like to offer you a little present. It is a crystal ash tray for the table in your conference room. On top you will see a watermark, used by Van Gelder Zonen for more than two centuries, at the bottom the coat of arms of the guild of papermakers.

In conclusion I may say that Mr. Beuker has requested me to give his best regards to all his American friends.

The principal address was delivered by Julian E. Tobey, President, Appalachian Coals, Inc., Cincinnati, Ohio, who discussed "Design Trends in Boiler Installations in the Pulp and Paper Industry in the South," a report which is the result of a survey of 37 southern pulp and paper mills.

Mr. Tobey said that installations in southern mills are far above average, and that maintenance of both old and new

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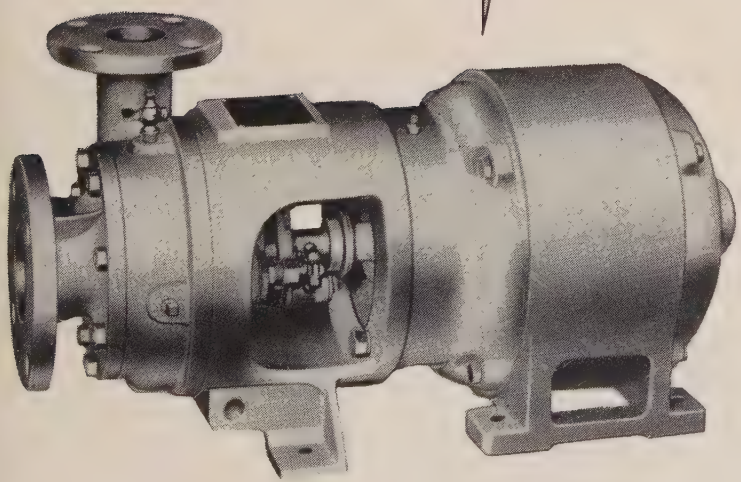

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J. E. Tobey addressing the group assembled for the Sixth Engineering Conference Luncheon

equipment is excellent. The trend in the industry is toward multiple fuel burners, he said, and he suggested that more mills consider the use of the topping unit, one of which is in operation at the Union Bag & Paper Corp. here. He predicted that the cost of coal would remain more constant in coming years than that of oil and natural gas which are in great demand in the present emergency.

Announcement was made of the appointment of C. J. Sibler, of the West Virginia Pulp & Paper Co., New York, N. Y., as General Chairman of the Engineering Division of the Technical Association of the Pulp and Paper Industry, and W. C. Bloomquist, of the General Electric Co., Schenectady, N. Y., as General Secretary.

The Mill Maintenance and Material Session opened the afternoon's activities. H. F. Parker, New York & Pennsylvania Co., the chairman, introduced K. S. Frazier, Detroit Steel Products Co., Detroit, Mich., who presented the paper "Use and Maintenance of Steel Windows in Pulp and Paper Mills."

Extreme humidities, acid vapors, and alkaline vapors are found in the various divisions of a paper mill. All of these elements create a maintenance problem above the average for industrial plants. The need for proper and scheduled maintenance of ferrous materials is apparent. Where lack of sufficient protective maintenance has allowed corrosion to gain the advantage, repair or replacement maintenance becomes the problem. With steel windows corrosion usually sets up first toward the bottom of the window and in weathering bars around the ventilators. When replacement bars are available these windows can be repaired by the simple expedient of removing the glass lights, cutting out the corroded bars, and welding in new bars. The difficulties of this method are clearing away the masonry sills and jambs to free the corroded bars, obtaining the proper replacement bars, and the cost of this type of maintenance. Cost will in many cases indicate replacement rather than repair.

It is recommended for replacement that postwar sizes of windows be selected because of their availability and lower cost. The manufacturer's representative can aid materially in this selection.

Masonry openings prepared so that windows can be installed after masonry is complete reduce installation costs, damage to units by other trades, and simplify the maintenance problem.

Proper paint often applied with periodic wire brushing before application is a good protection for steel although it is stated authoritatively that no paint used today is 100% impervious to moisture which is the medium of corrosion.

The hot-dip galvanizing of steel windows and ferrous hardware which is now commercially available provides a surface treatment which through the example of installations watched for periods of 20 and 30 years is a proved superior and enduring protection.

"Electrical Maintenance, Electronic Equipment," by G. R. Meyer, Westinghouse Electric Corp., was next on the program.

Having realized the importance of an adequate maintenance program, the importance of the establishment of systematic records cannot be overemphasized. There must be a record of operations to be preferred, and what was done to correct the trouble to prevent frequent reoccurrence.

The three greatest enemies of the continuous operation of electrical equipment are dirt, grease, and moisture. Because of the necessity for water in pulp and papermaking, moisture can be a problem but if you can't keep it dry at least keep it clean. The following simple instructions are recommended: (1) Wipe off direct with clean, dry cloth. (Note: Do not use waste.) (2) Blow out dirt with compressed air. (Note: Air pressure should not be over 50 pounds.) (3) Draw dirt out of ducts with vacuum (dry conditions). (4) Remove dirt with solvents. (5) Under extreme conditions wash off with water.

Lubrication is also a point to which attention should be directed. With the newer bearings, however, it is not as important as it used to be.

Electric motors should be inspected regularly if trouble-free operation is desired. Most inspections in a well-organized plant can be limited to the three senses: look (for any outward appearance of faulty operation), feel (for vibration, looseness, and heat), and listen (for any noise or unusual sounds).

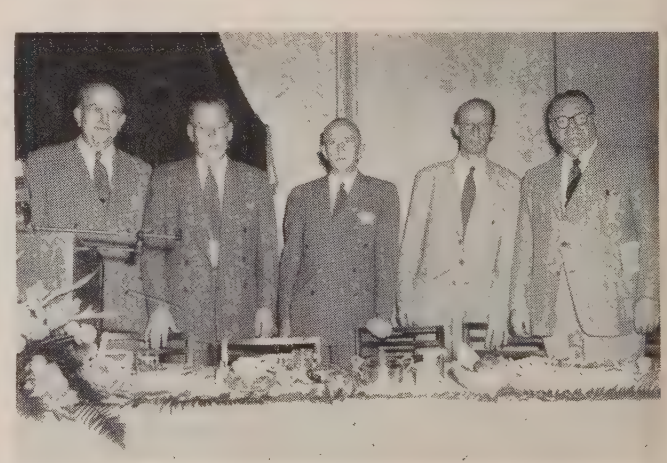
In regard to electronic equipment, maintenance should be assigned to one familiar with the equipment keeping in mind that if it is working within reasonable limits, leave it alone.

Mr. McNally was chairman of the Materials Handling Discussion Period in which methods and means of delivering pulpwood to the mill yard were considered.

The Drying and Ventilating Group studied a translation from German of a paper on the application of the laws of drying and ventilating to the design and operation of pulp and paper machine driers by Karl Schmitt.

Paul Corning, Rayonier, Inc., Fernandina, Fla., gave a report on maintenance of insulation in pulp and paper mills at the Mill Maintenance and Materials Discussion Session.

The ultimate purpose of investing in insulation is to save fuel, and to attain the best net saving from this type of investment any new or repair insulation project should be well planned. It would appear that there are three phases of a



Engineering Luncheon Head Table. Left to right: J. E. Tobey, Appalachian Coals, Inc.; G. H. Pringle, Mead Corp.; K. P. Geohegan, Howard Paper Mills Inc.; Ninck Blok, Van Gelder Zonen N.V.; and A. E. Bachmann, Missisquoi Corp.

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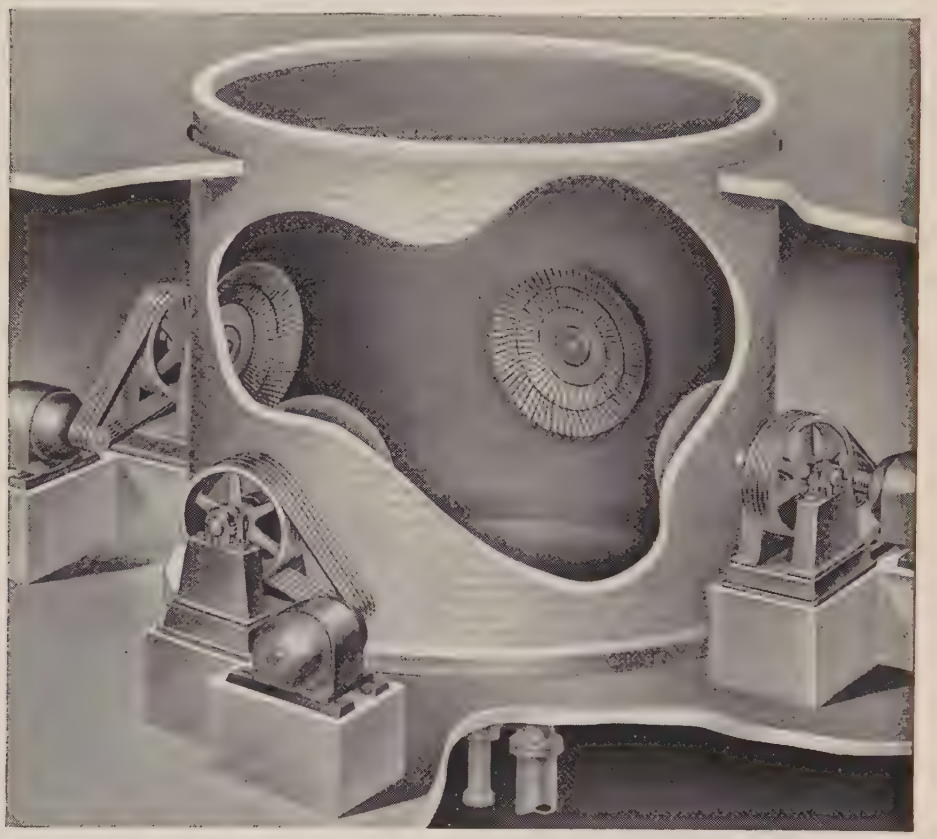

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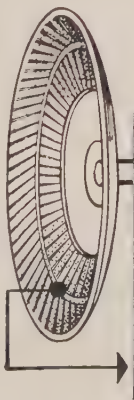

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well-engineered insulation installation: (1) selection of the most suitable type of insulation, (2) arrangements for a well-designed installation, and (3) adoption of a regular inspection and maintenance plan.

In connection with the selection of insulation, it was proposed that the round-table discussion include dissertations on physical properties and advantages of various insulations, the Asbestocite casing, the Ernst method of protecting insulation, and the use of plastics.

The get-together party Wednesday evening was sponsored by the Southern Paperboard Corp.

Thursday, Oct. 18, 1951

The morning of Thursday, the 18th, was devoted to a visit to the plant of the Union Bag & Paper Corp., in Savannah, the hosts at a barbecue luncheon which was held at noon at the Mary Calder Golf Course. In the afternoon, a visit was made to Port Wentworth, Ga., to the Southern Paperboard Corp. mill.

Ladies Program

A very enjoyable program of activities was arranged for the wives of members of the Sixth Engineering Conference of the Technical Association of the Pulp and Paper Industry. Mrs. R. T. Inman was in charge of the program and was assisted by a group of Savannah women.

Tuesday the visitors were entertained at a luncheon given at the Savannah Yacht Club. Luncheon was served on the terrace with attractive arrangements of pyracantha decorating the tables. Features of the program were Gullah stories told by Mrs. Arthur Wetherhorn and a group of spirituals by singers from the General Oglethorpe Hotel. Mrs. J. R. Lientz was in charge of arrangements for the luncheon, assisted by Mrs. Bullard Harris and others.

A tour of historic places in and around Savannah was also enjoyed Monday.

A card party was given Wednesday afternoon on the Sunrise Terrace at the General Oglethorpe and in the evening the ladies joined the men for the get-together party.

Thursday the ladies participated in the tour of plants of the Union Bag & Paper Corp. and the Southern Bag & Paper Corp. and attended the barbecue at the Mary Calder Golf Club at which the Union Bag was host.

Acknowledgements

A note of appreciation is in order for the cooperation of the managements of the Union Bag & Paper Corp. and the Southern Paperboard Corp. Without their assistance it would not have been possible to hold such a successful meeting.

Group of the ladies at the Engineering Conference in Savannah, Ga.

G. H. Pringle, Mead Corp., retiring chairman of the Engineering Division

C. J. Sibler, West Virginia Pulp & Paper Co., new chairman of the Engineering Division

Acknowledgment is also made to the Allied Industry sponsors for their help with the meeting.

The following are the individuals who shared the burden in the organization of the conference:

LOCAL ARRANGEMENTS COMMITTEE
Chairman: J. R. Lientz
Vice-Chairman: R. T. Inman

Allied Industries:
Chairman: Wm. McIntosh, Jr.
J. D. Robinson
P. B. Sowell

Housing:
Chairman: John Fielding
Bruce P. Ellen
R. F. Screnson
Dan Calkins

Miscellaneous Arrangements:
Chairman: J. J. Yirak
Alex Morris
Alex Ormond

Publicity:
Local: Kirk Sutlive
National: R. G. Macdonald

Transportation:
Chairman: H. W. Borman
C. C. Bush
H. B. Pratt, Jr.
L. F. Carriker

Plant Tours:
Co-Chairmen: H. L. Char, bonnier and Milton Ellis
J. J. Ward, Jr.
H. B. Harris, Jr.

Corrections

"Instrumentation Studies. LXVI. A Study of Photoelectric Instruments for the Measurement of Color: Reflectance and Transmittance" which was published in August 1951, pp. 126A–132A should be Instrumentation Studies. LXIV.

Instrumentation Studies. LXV. The K.B.B. Galvanic Size Tester, by Van den Akker and Hardacker which was published in the October 1951 issue of *Tappi*, pp, 137A–148A, should be Instrumentation Studies LXVI.

In the paper "The Permeation of Vapors Through Polyethylene" by Cutler, Kaplan, McLaren, and Mark in the September 1951 issue, pp. 404–407, the word "Water" should be deleted from the heading of the first column in both Tables I and II (the headings should simply be "v.p., mm. Hg"). In Table I the word "Water" should be over the number 1.7×10^{-13}, column 3, but under the bar below the headings (compare the position of "Propanol," "Acetone," etc.).

On page 78A of the September 1951 issue of *Tappi* under the curve accompanying the write-up on "Wall Friction Between Pulp and Glazed Tile," the velocity is given as 16 to 28 feet per second. This should be 0.16 to 0.28 feet per second.

In the TAPPI Suggested Method T 636 sm-51, Oil Content of Petroleum Waxes, in the September 1951 issue of *Tappi* as the first paragraph now reads "The sample of wax is not weighed after it is transferred to the test tube." This omission is corrected by adding the words "Swirl the test tube so as to coat the bottom evenly with wax. This permits more rapid solution later. Let cool, and weigh test tube plus wax to the nearest 1 mg."

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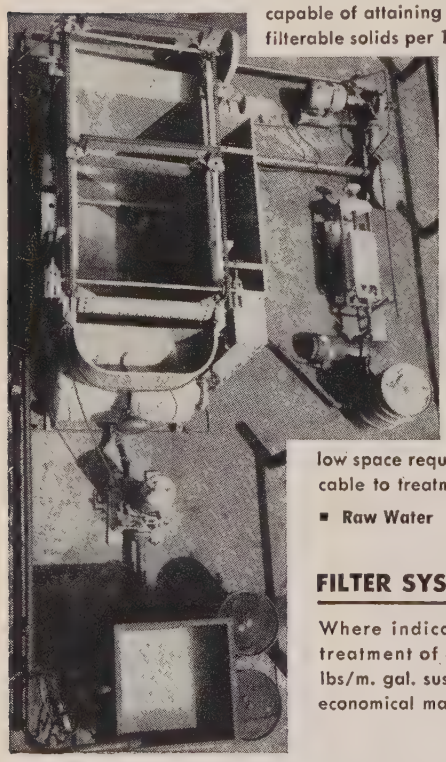

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RECENT BOOKS

Color Psychology and Color Therapy. By Faber Birren. McGraw-Hill Book Co., Inc., New York, 1950. Cloth, 6 × 9, 284 pages. $4.50.

The author is well known to most technical men who have had much to do with color. The book is nontechnical in nature and is devoted to a study of the influence of color on human life. Four major aspects are considered: historical, biological, psychological, and visual. Of industrial importance are such considerations as color harmony, influence of color on mental efficiency, color in personality tests, color code for safety, etc. Although theories are disguised by interesting writing the nonexpert will acquire a good knowledge of color fundamentals.

Heat Insulation. By Gordon B. Wilkes, Professor of Heat Engineering, Massachusetts Institute of Technology. John Wiley & Sons, Inc., New York, 1950. Cloth, 5½ × 8½, 224 pages. Illustrated. $4.00.

The author performs a service in bringing together in a concise way information that has been scattered through a large number of publications. Although it is not an elementary book it presents the important fundamental formulas covering the essential concepts required for an intelligent comprehension of the subject. These are simple and complete and should be of benefit to the technical man who may not be working in this field from day to day. Some of the subjects covered are: Methods of determining heat transfer coefficients; types of insulating materials; reflective insulation; specific heat, and moisture in insulation. Useful tables are appended to the volume.

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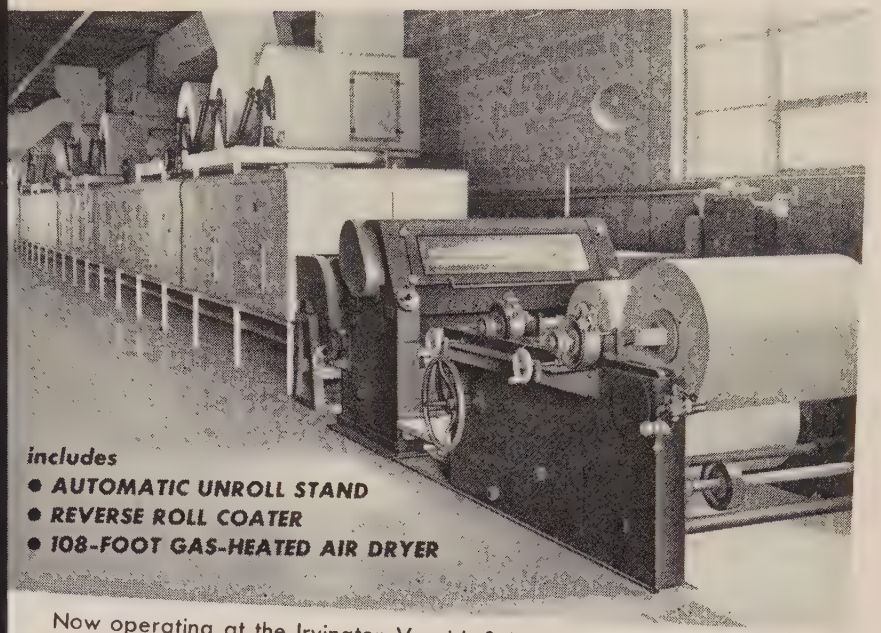

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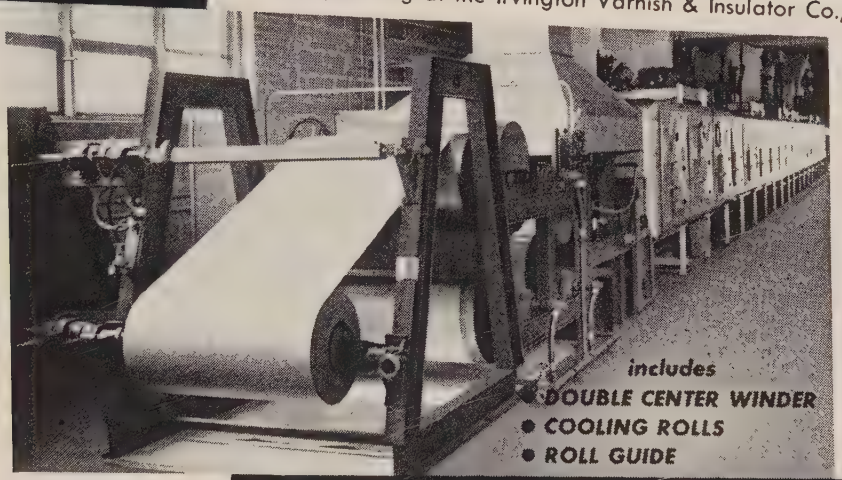

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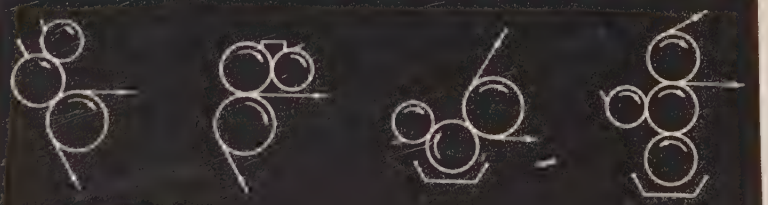

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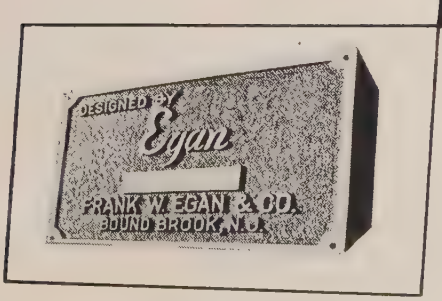

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New TAPPI Members

George W. Aljian, Director of Purchasing and Packaging, California & Hawaiian Sugar Refinery Corp. Ltd., San Francisco, Calif., a 1918 graduate of the University of California.

Stanley Baughman, Technical Superintendent, Container Corp. of America, Philadelphia, Pa., a 1943 graduate of Mount Union College.

Aldo Bernhard, Works Manager, Vereinigte Papierfabriken Netstal AG., Netstal, Switzerland, a 1942 graduate of Kothen, in Germany.

Rajaram V. Bhat, in charge of Administration and Research in Cellulose, Cellulose and Paper Branch, Forest Research Institute, New Forest, Dehra Dun (U. P.), India.

Charles E. Bouis, Project Engineer, Central Paper Co., Inc., Muskegon, Mich., a 1949 graduate of the University of California in Civil Engineering.

Emmett W. Bryan, Engineer, J. E. Sirrine Co., Greenville, S. C. Attended the Georgia Institute of Technology.

Juan R. Busco, Sales Manager, Papelera Rio Parana S. A., Buenos Aires, Argentina. Attended the University of Buenos Aires.

Heinz Corte, Research Associate, Zellstofffabrik Waldhof, Forschungs Laboratory, Mannheim-Waldhof, Germany, a 1949 graduate of the Universities of Göttingen and Heidelberg.

Lewis M. Cutter, General Supervisor, Container Corp. of America, Philadelphia, Pa., a 1945 graduate of the U. S. Naval Academy.

Harold A. DeRice, Mechanical Engineer, W. H. Rambo Engineers, Portland, Ore.

Charles C. DeYoung, Engineer, Thilmany Pulp & Paper Co., Kaukauna, Wis., a 1946 graduate of Marquette University.

Stanley P. Dittmar, Production Supervisor, Container Corp. of America, Chicago, Ill., a 1949 graduate of Northwestern University.

Arthur E. Drew, Chief Engineer, Southland Paper Mills, Inc., Lufkin, Tex., a 1927 graduate of the University of Saskatchewan.

Hugo Elling, Director of Research, Vereinigte Glanzstoff-Fabriken AG., Wuppertal, Germany, a 1922 graduate of the University of Gottingen.

Thomas A. Feazel, Development Chemical Engineer, Pilot Plant, Buckeye Cotton Oil Co., Memphis, Tenn., a 1951 graduate of Louisiana State University.

Ramon A. Fournier, Technical Manager in Coating and Graphic Arts, Hijos de Heraclio Fournier, Vitoria, Spain, a 1933 graduate of the Commercial University, Deusto.

William G. Garlough, Assistant Purchasing Agent, Knowlton Brothers, Watertown, N. Y., a 1949 graduate of Clarkson College of Technology.

Robert W. Gassin, Mechanical Design Engineer, J. E. Sirrine Co., Greenville, S. C.

Carl A. Hamell, Engineer, Superfine Paper Mill, Inc., Clayville, N. Y.

Edward J. Heiser, Chemist, The Dow Chemical Co., Midland, Mich., a 1950 graduate of New York State College of Forestry.

Casper V. Henkel, Jr., Chief Chemist, The Mead Corp., Lynchburg, Va. Attended Lynchburg College.

Alfred K. Hobbs, Graduate Student, Lowell Textile Institute, Lowell, Mass., a 1950 graduate of the University of Maine.

Eberhard Holzapfel, Technical Manager, Erwin Behn Papiersackfabriken, Krefeld, Germany, a 1923 graduate of the Colleges of Munster and Halle.

Robert S. Johnston, Chemist, McLaurin, Jones Co., Brookfield, Mass., a 1943 graduate of Massachusetts State College.

Lester M. Kapp, Chief Electrician, St. Regis Paper Co., Pensacola, Fla. Attended the University of Cincinnati and Miami University.

Paul R. Kinsey, Chemical Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1951 graduate of Purdue University.

Richard G. Kuerzi, Wood Yard Superintendent, St. Marys Kraft Corp., St. Marys, Ga., a 1931 graduate of Fordham University.

John O. Logan, Sales Manager, Mathieson Chemical Corp., Baltimore, Md., a 1931 graduate of Shurtleff College.

John. W. Morgan, Chief, New Facilities and Equipment Branch, Pulp, Paper and Paperboard Div., National Production Authority, Washington, D. C., a 1924 graduate of Ohio University.

Delbert J. Morrison, Staff Accountant, Oxford Paper Co., Rumford, Me.

Charles D. Nitchie, Chief Engineer, Samuel M. Langston Co., Camden, N. J., a 1932 graduate of Cornell University.

Anthony J. Parrino, Tour Foreman, Macon Kraft Co., Macon, Ga. Attended Louisiana State University.

Leslie P. Peck, Laboratory Technician, National Folding Box Co., Inc., New Haven, Conn., a 1950 graduate of Clarkson College of Technology.

James M. Piette, Construction Engineer, Union Bag & Paper Corp., Savannah, Ga., a 1946 graduate of Purdue University.

Richard Pietro, Chemist's Assistant, Mohawk Paper Mills, Inc., Cohoes, N. Y.

Alex E. Reikes, Power Transmission Engineer, Graton & Knight Co., Worcester, Mass. Attended Columbia University.

Linwood N. Rogers, Director of Research, Buckeye Cotton Oil Co., Memphis, Tenn., a 1925 graduate of the University of Virginia.

Edward Small, Jr., Sales and Development, Krafelt Co., Wilmington, Del. Attended Union College.

Ralph H. Sogard, Plant Engineer, Escanaba Paper Co., Escanaba, Mich., a 1926 graduate of the University of Wisconsin.

Don L. Stacey, Pulp Mill Manager, New Zealand Forest Products Ltd., Auckland, N. Z., a 1942 graduate of the University of New Zealand.

Henry A. Stoess, Jr., Sales Engineer, Fuller Co., Catasauqua, Pa.

James M. Sturkey, Sales Engineer, Northwest Filter Co., Seattle, Wash., a 1942 graduate of North Carolina State College.

Glen Sutton, Superintendent, Sutherland Paper Co., Kalamazoo, Mich.

William R. Talley, Tour Foreman, Macon Kraft Co., Macon, Ga.

George W. Thomas, Assistant Manager, Development Dept., Wood Conversion Co., Cloquet, Minn., a 1939 graduate of the Illinois Institute of Technology.

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For many years, Nopco wax sizes internally applied have set the standard for quality, uniformity and superb performance. The designations Nopco 2251 and Nopco 2252 have come to symbolize beater sizes that couldn't be beat!

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Kurt Tramer, Consultant, Zschimmer & Schwartz, Chemische Fabrik und Gerbstoffwerk AG., Oberlahnstein, Germany, a 1925 graduate of the Institute of Paper Technology, Kothen, Germany.

Herbert A. Wells, Director, Coatings Div., American Resinous Chemicals Corp., Peabody, Mass., a 1938 graduate of the University of North Carolina.

Robert C. Williams, Plant Technician, Central Paper Co., Menasha, Wis., a 1948 graduate of Lawrence College.

Daniel F. Williamson, Field Engineer, Sandwell & Co. Ltd., Vancouver, B. C., Canada, a 1949 graduate of the University of British Columbia.

Robert H. Wood, Research Chemist, Minnesota Mining & Manufacturing Co., St. Paul, Minn., a 1927 graduate of the University of Minnesota.

Robert H. Woods, Project Engineer, Marathon Corp., Menominee, Mich., a 1942 graduate of Marquette University.

TAPPI Notes

John H. Ainsworth, formerly of the Allied Paper Mills, is now Technical Director of the Central Paper Co., Muskegon, Mich.

R. Ellsworth Annis, Jr., formerly of Cornell Paperboard Products, Inc., is now Plant Engineer for the Fitchburg Paper Co., Fitchburg, Mass.

Raymond H. Atwood, formerly of the University of Maine, is now Chemist for the Penobscot Chemical Fibre Co., Great Works, Me.

Donald E. Baker, formerly Technical Supervisor of the St. Regis Paper Co., is now with the Tennessee Paper Mills, Inc., Chattanooga, Tenn.

Lyman A. Beeman is now President of Finch, Pruyn & Co., Glens Falls, N. Y.

Mathias Boland, formerly of the Cowles Chemical Co., is now in the research laboratory of Columbia-Southern Chemical Corp., Barberton, Ohio.

Gerald L. Burke, formerly student at the N. Y. State College of Forestry, is now Quality Control Supervisor for the Arkell Safety Bag Co., Newport News, Va.

John M. Dyer is now General Manager of White-Washburn, Inc., with offices at the A.P.W. Products Co., Inc., Albany, N. Y.

James P. Dwyre, formerly student at the N. Y. State College of Forestry, is now in the Technical Service Dept., West Virginia Pulp & Paper Co., Covington, Va.

Charles N. Egan, President of the Little Rapids Pulp Co., has moved his offices from West De Pere, Wis., to Green Bay, Wis.

Julius Grant is Director of New Bury Paper Mills, Ltd., Gigg, Bury, Lancs, England, and also of Thomas Owen & Co., Ltd., Cardiff, Glam, Wales.

Parker W. Gray, formerly graduate student at the University of Michigan, is now Chemical Engineer for the Kimberly-Clark Corp., Neenah, Wis.

A. P. Gregory is now Superintendent of the Groundwood, Sulphite Pulp Wood Room and the Bleach Plant of the St. Regis Paper Co., Bucksport, Me.

Raymond A. Greene, Sales Representative of the Merrimac Div., Monsanto Chemical Co., has been transferred from Everett, Mass., to New York City.

Pekka R. Haarla is now Assistant Manager of the Haarla Pulp Co., Tampere, Finland.

John D. Haskell is now Executive Vice-President of the Black-Clawson Co. and will continue to be located at the Dilts Machine Works Div., Fulton, N. Y.

L. R. Hollander, formerly of the Mobile Paper Co., is now Engineer for the Stone-Mann Paper Co., Mobile, Ala.

Charles M. Howell, formerly of the Scott Paper Co., is now Lecturer in the Chemical Engineering Dept., University of Maine, Orono, Me.

Hannes A. Jansson, formerly of Enso-Gutzeit O/Y, is now Managing Director of Jontseno Pulp O/Y, Jontseno, Finland.

Morris Kaplan, formerly of the Mercer Paper Tube Co., is now President of the Gardiner Paper Mills, Inc., Gardiner, Me.

Krishna K. Khandelwal, formerly student at the University of Maine, is now a graduate student in the Chemical Engineering Dept., Syracuse University, Syracuse, N. Y.

John G. Leech, formerly student of The Institute of Paper Chemistry, is now in the Research Dept., West Virginia Pulp & Paper Co., Luke, Md.

Robert W. Lewis of the Container Corp. of America, has been transferred from Manayunk, Pa., to Los Angeles, Calif., as an Engineer.

Alvaro de la Macorra, formerly student at the University of Maine, is now a Trainee at the Union Bag & Paper Co. mill in Savannah, Ga.

Frank Makara, Patent Attorney, is now located at 123 Saddle Lane, Levittown, N. Y.

George E. Martin, formerly of the Mosinee Paper Mills Co., is now Group Leader in the Research and Development Div., Fibreboard Products, Inc., Antioch, Calif.

Hoke Martin of the Hercules Powder Co. of Canada, is now Manager of the Paper Makers Chemical Dept., Hercules Powder Co., Kalamazoo, Mich.

Edward J. Meier of the Technical Service Dept., Paper Chemicals Div., American Cyanamid Co., has been transferred from Chicago to New York City.

Clinton A. Mohler, formerly of the Mead Corp., is now a Sales Engineer for the Foxboro Co., Foxboro, Mass.

Horst Niethammer, formerly of Heinrich Nicolous A/G, is now General Manager of Aschaffenburger Zellstoffwerke A/G, Redenfelden, Germany.

Edward K. Nisson, formerly of the Camp Mfg. Co., has joined the operating staff of the Nekoosa-Edwards Paper Co., Port Edwards, Wis.

Wilbur R. Noel, formerly of the Kalamazoo Paper Co., Kalamazoo, Mich., is now in the U. S. Armed Services.

Paul Onash, formerly of the Arkell Safety Bag Co., Newport News, Va., is now a Captain in the U. S. Air Forces in England.

Ernest R. Passow, formerly of the Nekoosa-Edwards Paper Co., is now a Process Engineer for the General Electric Co., Coshocton, Ohio.

Roderick A. Perkins, formerly Chemist for the Oregon Pulp & Paper Co., is now a student at the Western Michigan College, Kalamazoo, Mich.

Edgar M. Pierce, Consulting Engineer, has moved his offices from 683 Atlantic Ave., to 183 Essex St., Boston, Mass.

F. Dewart Robinson, Jr., formerly student at the N. Y. State College of Forestry, is now Chemical Engineer for the Union Bag & Paper Corp., Savannah, Ga.

Joseph Schoenberg, formerly Engineer for the Hudson Pulp & Paper Corp., Palatka, Fla., is now with Albert N. Weiss, Jenkintown, Pa.

Guy A. Schragg is now Assistant Chief, Physical Testing Branch of the Philadelphia Quartermaster Depot, Philadelphia, Pa.

James C. Shaw is now an Industrial Engineer for United Engineers and Constructors, Inc., Philadelphia, Pa.

Charles M. Sigvardt, formerly of the Celotex Corp., is now Technical Superintendent of the Nekoosa-Edwards Paper Co., Nekoosa, Wis.

Edward H. Snider is now Research Engineer for the Canadian International Paper Co., Ltd,. Gotineau, P. Q.

Andrew J. Snyder, formerly of Reichhold Chemicals, Inc., is now Professor of Chemistry at the University of Alabama, Tuscaloosa, Ala.

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Controllability analysis predicts actual results. Through long experience with pH control applications, we have developed a unique system of "controllability analysis." By scientifically weighing all pH control factors—type of waste, treating system, reagent—this analysis determines the net control effect possible for a given waste-treating system.

If you're planning pH control, you can't afford to miss this special service. Our catalog "Effective Neutralization of Industrial Wastes" explains controllability analysis in full detail. For your convenience, it also contains a simple questionnaire . . . so we can help you begin solving your plant's pH problems now. You can answer the questions in just a few minutes.

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James H. Snyder is now General Superintendent of the St. Regis Paper Co., Bucksport, Me.

O. H. Somers, Quality Control Engineer for the Western Printing and Lithographing Co., has been transferred from Poughkeepsie, N. Y., to Racine, Wis.

Frederick N. Sprague is now Superintendent of Technical Control, St. Regis Paper Co., Bucksport, Me.

Reavis C. Sproull, formerly of the Southern Research Institute, is now Technical Director of the Herty Foundation Laboratory, Savannah, Ga.

Elmer K. Stilbert is now Assistant Manager of Coatings Technical Service, Dow Chemical Co., Midland, Mich.

Benjamin M. Thomas, formerly of the Ohio Boxboard Co., is now located in the Charles Apartments, 3333 N. Charles St., Baltimore, Md.

Graham Trethewey is now Research Chemical Engineer for Alaska Pine & Cellulose, Ltd., Woodfibre, B. C.

Allan T. Walsh, formerly of the Riegel Paper Corp., is now Chemical Engineer for the General Electric Co., Chemical Dept., Laminated and Insulating Products Div., Coshocton, Ohio.

Paul Weishaar, formerly student at the N. Y. State College of Forestry, is now a Paper Mill Technical Trainee for the Personal Products Corp., Milltown, N. J., and is at present on leave of absence while serving in the U. S. Army.

David Wetherhorn is now a Project Engineer for the Southern Paperboard Corp., Port Wentworth, Ga.

James D. Wethern, formerly student at The Institute of Paper Chemistry, is now a Service Research Chemist in the Pulp Div., Central Research Dept., Crown Zellerbach Corp., Camas, Wash.

J. M. Wheaton is now Manager of Research and Packaging Development, Owens-Illinois Glass Co., Toledo, Ohio.

Robert C. Whitney, formerly student at the N. Y. State College of Forestry, is now a Technical Trainee for the Personal Products Corp., New Brunswick, N. J.

* * *

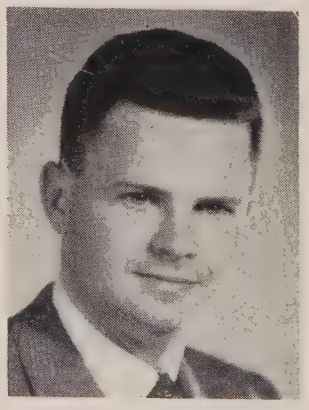
Denman Peniston, Director of Sales, has succeeded John V. Stauf, Vice-President, as the official representative of the Solvay Sales Div., Allied Chemical & Dye Corp., New York, N. Y., in the Technical Association.

James F. Reynolds has succeeded R. M. Upright as the official representative of the Dow Chemical Co., Midland, Mich., in TAPPI.

Joseph E. Bradbury, Manager of Alloy Sales, has succeeded John A Minser as the official representative of Crane Co., Chicago, Ill., in the technical organization.

R. Burke Morden has been elected President of Morden Machines Co., Portland, Ore. He succeeds his father in this position. R. Blakeley Honeyman was elected Vice-President. Darrah Corbet continues as Secretary-Treasurer.

R. Burke Morden



R. Blakeley Honeyman

C. W. Morden organized the Company in 1931 to manufacture the Stockmaker, a machine that he invented for beating and refining pulp. More than 500 of these machines are in use in 130 mills in twenty countries. In October the Company offices in Portland were moved from the Pacific Building to the Corbet Building.

Industry Notes

Bird & Son plans to increase the capacity of its Shreveport, La., felt mill. Rust Engineering Co. of Pittsburgh has been appointed to handle the construction. Capacity will be increased from 60 to 120 tons per day.

* * *

H. R. MacMillan Export Co. has started the erection of an addition to its Nanaimo sulphite mill in British Columbia. Eight digesters will be added.

* * *

Total paper and board production in the first six months of 1951 broke previous records. 13,746,000 tons, or about 18% more, were produced in 1951 than in the corresponding 1950 period.

* * *

The first sheet-fed, fine-color offset press is being installed in the Stecher-Traung Lithograph Corp. plant at San Francisco. The press was built by Harris-Seybold Co. The press is 66 feet long and $9^1/_2$ feet high.

* * *

The Buckeye Cellulose Corp. has purchased over 500,000 acres of pine land near Perry, Fla., for its proposed dissolving pulp mill. 125,000 acres were purchased from P. C. Trapp & Son and 440,000 acres from Brooks-Scanlon, Inc. The Buckeye Cotton Oil Co., also a subsidiary of the Procter & Gamble Co., has a pulp mill in Memphis, Tenn., using cotton linters.

* * *

The Gannett Co. of Rochester, N. Y., has purchased the Berwin Paper Mfg. Co. of Dansville, N. Y. The Gannett Co. controls several newspapers.

* * *

Finland's plans for shipping pulp to the United States have not been changed, despite the United States' imposition of price ceilings on imported pulp. Earlier estimates of about 165,000 metric tons to be sent to this Country in 1951 are expected to be fulfilled.

* * *

In the packaging of potatoes from 50 to 60% of the bags used in New Jersey are made of paper. On Long Island in New York from 60 to 70% of the bags are made of paper. In Maine it is at least 80%. Formerly all potatoes were packaged in burlap bags.

* * *

New Zealand is calling for bids for the establishment of an 86 million dollar paper and pulp industry using timber from the man-made Kaingaroa State Forest near Rotorua to include rights to purchase 23 million cubic feet of softwoods annually for a period of 75 years.

* * *

A summary of the facilities expansion program of the Defense Production Administration shows that priority in accelerated tax amortization continues to be given to producers of basic materials. In the pulp and paper industry 69 applications have been approved with a proposed investment

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of $486,853,000, with an allowable tax amortization of $280,027,000 (57.5% of property investment).

* * *

Paper and paperboard production in New England in the first half of 1951 was nearly one sixth above the first half of 1950. With the second half output equal to that in 1950, annual tonnage would reach a new peak of around 3 million tons. Paper supplies remain tight for most grades and signs of any pronounced slackening in mill activity are absent although order backlogs have been reduced. Many users are finding it necessary to carry larger inventories to compensate for frequent delays in mill deliveries.

* * *

Bowater Paper Corp. Ltd.'s projected Tennessee newsprint and sulphate pulp mill, including woodlands, is expected to cost in excess of $50,000,000. The annual capacity of the proposed mill will be 125,000 tons of newsprint and 50,000 tons of unbleached sulphate pulp. Plans call for selling the mill's entire output in the United States, in addition to including newsprint shipments from the Company's main mill in Newfoundland. The mill is planned for the Charleston-Calhoun area in Tennessee.

* * *

The N.P.A. reports the current sulphur picture as follows: about 1,100,000 long tons of sulphur will be consumed in the United States during the fourth quarter if the present rate of consumption is permitted to continue.

Canada which operates under the same limitations, would consume 81,500 tons.

Exports, if they follow the pattern for the first three quarters of 1951, will be about 257,000 tons.

The total of these is 1,438,500 tons. Production for the fourth quarter, however, is estimated at 1,338,500 tons, which would leave a deficit of 100,000 tons.

* * *

Elwood V. White has joined the staff of The Institute of Paper Chemistry as a Research Associate and Group Leader in the field of carbohydrate chemistry. Until recently he was Professor of Chemistry at the University of British Columbia.

* * *

The N.P.A. reports the following breakdown of production of printing paper grades in short tons for the first six months of 1951 compared with the same period of 1950:

	1951	*1950*
Groundwood (uncoated)	383,000	331,000
Machine coated	569,000	486,000
Book (uncoated)	834,000	791,000
Fine papers	677,000	596,000

* * *

More waste paper was purchased during the third quarter of this year, ending on September 30, than in any third quarter of any year since the end of World War II. More waste paper was purchased and consumed in the eastern mills during the first three quarters than was purchased and consumed during the entire year 1949. In the third quarter waste paper consumption dropped 26.6% from the second quarter.

* * *

The National Association of Corrosion Engineers will meet in Galveston, Tex., on March 10–14, 1952.

* * *

A new laboratory building, costing about $100,000, has been completed by Bloedel, Stewart & Welsh, Ltd., Port Alberni, B. C. The building is 90 by 40 feet with two floors and was designed by Allan C. Smith of Vancouver, B. C. For the present only the ground floor will be occupied, the top floor being held in reserve for the establishment of a research department.

As a first step toward obtaining additional heat recovery and further experimental work in reduction of mill odors, equipment consisting of a cyclone, condenser, accumulator tank, etc. has been installed on the blow tank. The design was by Halvar Lundberg of Seattle, and the construction was carried out by the Victoria Machinery Depot of Victoria, B. C.

* * *

Joseph L. McCarthy of the University of Washington, Seattle, Wash., is the new Chairman of the Division of Cellulose Chemistry of the American Chemical Society.

* * *

Testing Machines, Inc., 123 W. 64th St., New York 23, N. Y., have issued a new catalog of testing machines.

* * *

The National Container Corp. has awarded to Merritt-Chapman & Scott a contract to design, construct, and equip a 500-ton kraft pulp, paper, and board mill at Valdosta, Ga.

* * *

Plans for a new kraft mill at Red Deer, Alberta, costing $20 million, and financed by United States capital has been announced. The daily capacity is expected to be 200 tons of bleached sulphate. The mill should be in operation in 1953 or 1954.

* * *

Nine students enrolled in the chemical engineering department of the University of Maine have been awarded scholarship grants for the current school year by the U. of M. Pulp and Paper Foundation. These scholarships provide about $1000 for the completion of the last two years of the management option of the pulp and paper curriculum.

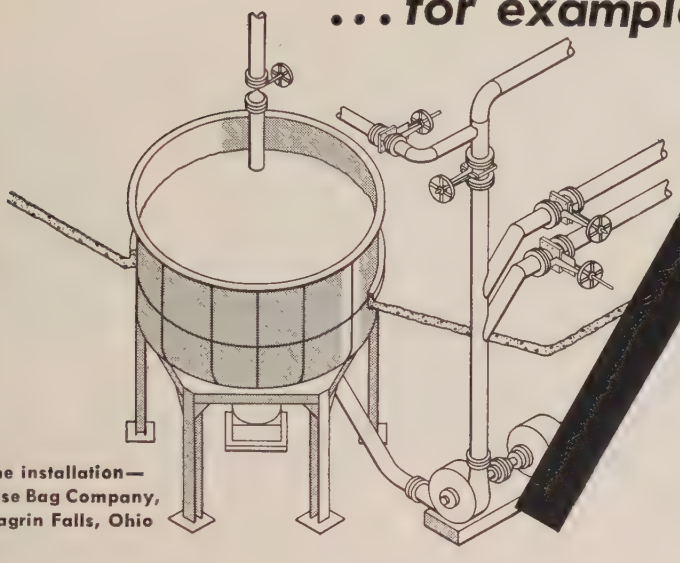
University of Maine students awarded scholarships by the University of Maine Pulp and Paper Foundation. Left to right: MacKinnon, Zabe, Webber, Fyre, Ayer, Butler, McClure, Pomeroy, and Perry

Recipients of the scholarships for this semester are: James E. Ayer, Bangor; Frank A Butler, Verona, N. J.; Dwight D. Fyre, Bucksport; Donald R. MacKinnon, Orono; John M. McClure, Glendale, Calif.; Robert E. Perry, South Freeport; William E. Pomeroy, Bath; Roy P. Webber II, Portland; and Robert N. Zabe, Bangor.

for outstanding service

on High-consistency Stocks

. . . for example



The installation—
Chase Bag Company,
Chagrin Falls, Ohio

PROBLEM: To find a satisfactory replacement for valves in pulper outlet lines, causing frequent and costly shutdowns for clean-out of pulp stock trapped in valves.

WORKING CONDITIONS: Consistency of stock normally handled about 6%. Pulper operation continuous. Water temperature approximately 140 deg. F. Valves operated infrequently.

SOLUTION TO PROBLEM: Crane No. 1425 Non-clogging, Self-cleaning, Bonnet-less Pulp Stock Valves, featuring the patented *combing-and-shearing action* disc and seating design. Knife-edge disc shears through combed fibers to seat easily against lead stop.

RESULTS: In more than 5 years' service, Crane Valves have not required a single shutdown for cleanout. Clogging completely eliminated. Only routine maintenance given to valves.

Another typical case history demonstrating how Crane Quality Valves give greater satisfaction at low ultimate cost. And why . . . More Crane Valves are used than any other make!

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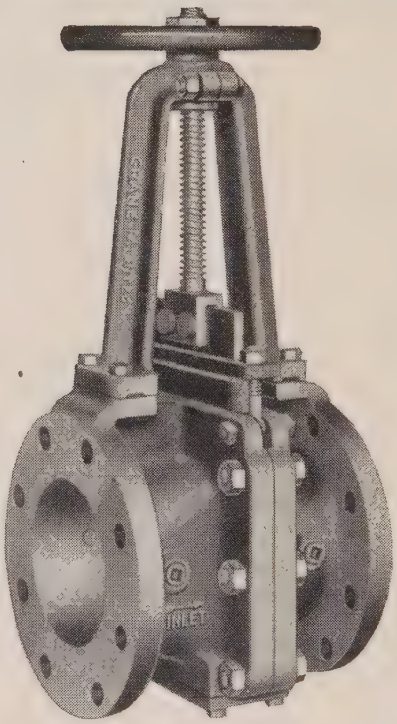
CRANE VALVES



No. 1425 Crane Iron Body Pulp Stock Valve. Get literature on this line from your local Crane Branch or Crane Wholesaler.

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Volume X, Barrell's Paper Annual has been issued as a 96-page, bound volume. This volume, now well known in the industry, contains a Directory of Officials of Trade Association in the industry, an article "Keeping Pace with Paper Making," and a revised edition of Paper Trade Terms by William Bond Wheelwright. Volume X has been distributed to paper manufacturers with the compliments of William L. Barrell Co., of Lawrence, Mass. The book was prepared by The Callaway Associates, 172 Summer St., Boston 10, Mass.

* * *

Paul B. Fowler, Sales Engineer for E. D. Jones & Sons Co., is recovering from a recent operation at Cooley-Dickinson Hospital, Northampton, Mass. S. Harley Jones, President of E. D. Jones & Sons Co., is recovering from an emergency appendectomy at Frisbie Memorial Hospital, Rochester, N. Y. He was taken sick unexpectedly while on a hunting trip.

* * *

Announcement is made of the consolidation of the previously affiliated American Bitumuls Co. and Stancal Asphalt and Bitumuls Co. A single national company has been formed under the name of American Bitumuls and Asphalt Co., having the collective manufacture and sales facilities of fourteen district offices and factories in the United States and Puerto Rico.

The company manufactures emulsified asphalts, under the trademark of "Bitusize," well known in the paper and board industry for waterproof sizing and adhesive extender agents. Executive Offices of the new company remain in San Francisco. E. M. Lorenzini, Manager in charge of their Bitusize operations, maintains his headquarters in Chicago.

* * *

John D. Haskel is now Executive Vice-President of the Black-Clawson Co., Hamilton, Ohio. In this position Mr. Haskell will direct the activities of all divisions and subsidiaries, including the export organization and B-C International, Ltd. with headquarters in London, England.

In 1919 Mr. Haskell was employed by the Management Engineering & Development Co. In 1921 he assumed engineering responsibilities with Dilts Machine Works, Inc. Under his direction the Hydrafiner was developed in 1933, to be followed by the Classifiner in 1935. In 1939 the development of the Hydrapulper culminated the pioneering phases of a new line of stock preparation equipment. He will continue to be located at Fulton, N. Y.

* * *

The Dilts Machine Works, Fulton, N. Y., announces that they have on hand a number of 3-foot diameter pilot plant Hydrapulpers which can be made available to any mill desiring to test the merits of the machine as applied to their own stock preparation systems.

* * *

The Cowles Co. recently entertained 19 Shartle, Dilts salesmen at its Cayuga, N. Y., plant. The salesmen witnessed laboratory demonstrations of the Cowles side-drive pulper and the newly developed Cowles pulper-refiner. Tests for pulping and fiber strength development on Taconia bleached kraft and on kraft clippings were run in a lab size side-drive pulper with a knife mill attachment and similar tests were run using a commerical size side-drive pulper using 900-pound batches of corrugated and kraft clippings.

* * *

General Mills, Inc., Minneapolis, Minn., has expanded production of polyamide resin suspensoids. This material, introduced in 1950, is used as heat-sealing adhesives and coatings. They are said to be resistant to greases, oils, water and water-vapor, and are nonblocking. The polyamide resins are formed by the condensation of dimerized vegetable oil acids with ethylene diamine. When applied as water suspensoids, they form opaque, white films composed of discrete particles, indistinguishable to the naked eye. When heat-fused, these films become continuous.

* * *

The Williams Gauge Co., 1620 Pennsylvania Ave., Pittsburgh 33, Pa., has issued an interesting bulletin (WH-851) on Water Hammer, Cause, Effect and Control in Piping Systems. The tests reported reveal that water hammer is caused by the sudden stopping of a column of water, and that its intensity is governed by the velocity with which the water is traveling at the moment of stoppage. The energy exerted by stopping the flow is taken up in the piping and equipment. If great enough, the action causes damage and is very likely to cause noises. However, water hammer is not necessarily accompanied by noise.

It has been proved that the theoretical figure of 54 p.s.i. for each foot per second of velocity that is stopped by the valve is essentially correct, and with the instantaneous closure of the valve a pressure of 540 p.s.i. is possible with a flow velocity of 10 f.p.s. This is true where ordinary outflow valves are used, but where a dead end exists, as with a check valve, the pressure may increase tremendously.

* * *

A southern paper mill reports that a neoprene-covered center roll in a dual press has been in service for more than a year. Because of the resilient nature of the neoprene covering, felt life has been increased by more than 60%. This item alone repaid the cost of the covering in four months. There is no evidence of bond failure and no doctor knife is needed to free the roll of fibers since the covering releases the sheet readily with practically no fiber pickup.

* * *

Michael Pope has been admitted as a junior partner in the consulting engineering firm of Myers & Addington, 21 E. 40th St., New York 16, N. Y.

* * *

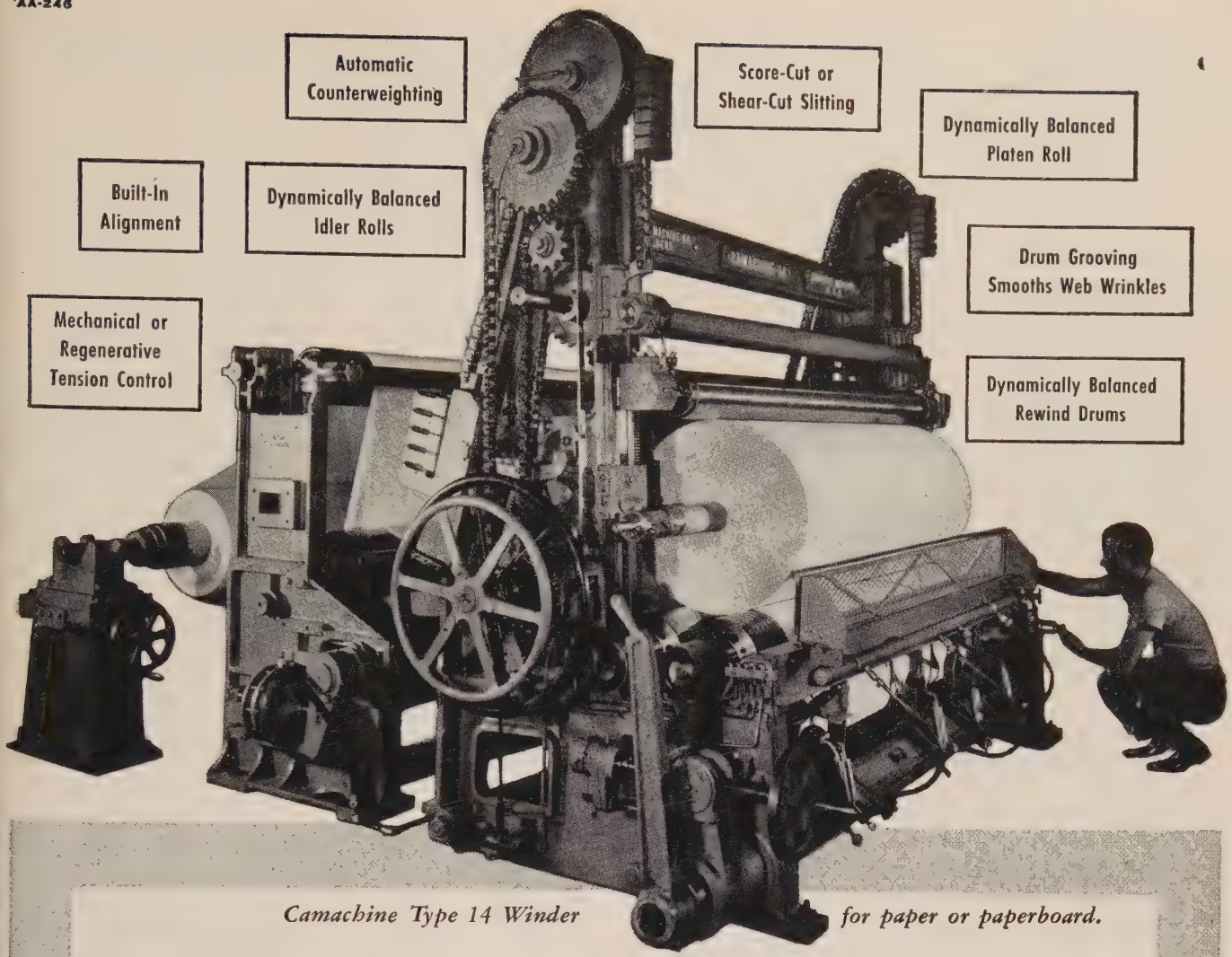
Several technical bulletins have been issued by Infilco, Inc., Box 5033, Tucson, Ariz. These include (W-800) Quiescent Clarification; (W-850) The Cyclator; (215) Type E Dry Chemical Feeders; (70A) Waste Treatment to Comply with Stream Pollution Control Regulators; and (50-I) Products and Processes for Industry.

* * *

Data and specification sheets recently issued by the Brown Instruments Div., Minneapolis-Honeywell Regulator Co., Wayne and Windriner Aves., Philadelphia 44, Pa., include the following: Vacuum Breakers (413-1); Measuring Tank Control System for Alkaline Digesters in Pulp Plants (2.9-18a); Air-Operated Diaphragm Motor Valves (408-2); and Liquid Level Controllers (412-2).

* * *

The Sutherland Refiner Corp., Trenton, N. J., has issued a bulletin describing a machine for the selective defiberizing of pulps and waste papers that also removes tramp metal. Called the Breaker Trap, the machine will handle up to 350 tons per day, and uses from 50 to 200 horsepower. It is normally installed between the pulp storage and subsequent equipments, and operates at the capacity of the equipment that follows it. In a high-yield system it is installed between the blow tank and the brown stock refiners and in a low-yield system, it would be located between the blow tank and the washers, and would take the place of pre-knotters.



Camachine Type 14 Winder for paper or paperboard.

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One practical reason is that Cameron Machine Company provides a choice between *four* great, job-proved mill-type Camachines . . . each designed to meet a specific range of speed and capacity requirements . . . each backed by Cameron's half century of *specialized* experience.

CAMACHINE TYPE 20. Dynamically balanced to the maximum speed of 5000 fpm. Trim widths from 180″ to 310″. Built to your choice of 42″, 60″, or 72″ maximum rewind diameter.

CAMACHINE TYPE 18. Dynamically balanced to the maximum speed of 2500 fpm. Trim widths from 73″ to 150″. Built to your choice of 42″, 60″, or 72″ maximum rewind diameter.

CAMACHINE TYPE 19. Dynamically balanced to the maximum speed of 3500 fpm. Trim widths from 117″ to 192″. Built to your choice of 42″, 60″, or 72″ maximum rewind diameter.

CAMACHINE TYPE 14. Dynamically balanced to the maximum speed of 1800 fpm. Trim widths from 53″ to 92″. Built to your choice of 38″, 50″, or 60″ maximum rewind diameter.

Write for complete information • **CAMERON MACHINE COMPANY** • **61 POPLAR STREET** • **BROOKLYN 2, N.Y.**

CAMACHINE — the one outstanding name in roll production equipment

At the recent meeting of the American Institute of Mining and Metallurgical Engineers, J. C. Carrington of the Freeport Sulphur Co., New York, N. Y., mentioned 46 projects, including 24 in the United States, to produce sulphur in different forms from different sources. These are expected to yield about 3 million long tons of sulphur by the end of 1953. The present world shortage is above 1 million tons a year.

Of the 24 projects in the U.S.A. four are new brimstone mines and one the expansion of an existing mine with a total anticipated new production of 1,200,000 long tons. One of the new mines is in operation. A second is scheduled to start production in the first half of 1952, another by the end of the same year, and the fourth, the newly discovered deposit at Garden Island Bay in Louisiana which Freeport will develop, by the end of 1953. Other projects are expected to add 350,000 tons of sulphur from natural gas, petroleum refinery gas, smelter gases, pyrites, and low-grade surface deposits of sulphur.

Seven projects in Canada and four in Mexico with an estimated new production of 500,000 tons of sulphur in all forms. A plant to mine sulphur by the Frasch (hot water) process will be built at a salt dome deposit on the Mexican Isthmus of Tehuantepec.

Expansion of pyrites production in Spain by increasing the annual rate of output at mines in Huelva Province by an amount estimated to be the equivalent of 400,000 long tons of sulphur. The Spanish mines have vast reserves, but production is now a little more than one half the prewar rate.

Increases planned by Italy in the output of native sulphur amounting to about 250,000 tons yearly.

Projects in Great Britain, Australia, Colombia, Japan, Norway, and Ecuador to obtain more sulphur in various forms from anhydrite refinery gases, pyrites, and native deposits.

Carrington said free world sulphur production from all sources this year probably will exceed 1950 output of 10,700,000 long tons of which approximately 6,000,000 tons were contributed by the United States.

* * *

Robert C. Landon, Manager of Industrial Relations of the Rohm & Haas Co., Philadelphia, Pa., has been appointed to serve as a member of the Appeals and Review Committee of the Wage Stabilization Board.

* * *

The Westinghouse Electric Corp., East Pittsburgh, Pa., will undertake a $296,000,000 expansion program extending beyond 1953. This will be the second such program undertaken since the end of World War II. The first, announced in 1945, was completed in 1948 at a cost of about 150 million dollars and increased manufacturing facilities by 50%.

A special program dramatizing the nation's critical need of engineers will be featured on "Adventures in Research," the Westinghouse radio science show broadcast to over 300 stations during the week beginning, November 25. Entitled "Supermen Wanted," the transcribed public service feature will highlight the role of the engineer in the technological growth of the nation and emphasize the present shortage of technical man power. Estimates indicate that by 1954 the number of engineering graduates will be 40% below the minimum requirements of 30,000 a year. The program is designed to aid in the educational campaign now being undertaken by the Engineering Manpower Commission of Engineers' Joint Council to bring the man-power shortage to the attention of the American people.

Westinghouse, Box 2099, Pittsburgh 30, Pa., has issued Booklet B-4791 on Protective Lighting. This deals with outdoor lighting for plant safety and security.

From 1920 to 1951 installed generating capacity increased from 13 million kw. to 75 million kw. In the same time generated kilowatt-hours increased from 40 to 360 billion. In 1961, it is expected that the installed generating capacity will reach 140 kw., and the annual rate of generation at over 600 billion kw.-hr.

* * *

The Third Plant Maintenance Conference will be held, concurrently with the Plant Maintenance Show, at Convention Hall, Philadelphia, on Jan. 14–17, 1952.

* * *

Stanley W. Brooks has been appointed Chief Engineer of H. W. Butterworth & Sons Co., Bethayres, Pa. Mr. Brooks was Chief Engineer of the Textile Finishing Machinery Co., Providence, R. I., when it was purchased by Butterworth in 1944.

* * *

Neal M. Draper, formerly Manager of the St. Louis branch of the Solvay Sales Co., is now Manager of the Ammonium and Potassium Products Dept. in New York City. Harry R. Stoothoff, formerly Manager of the Chicago office, will become Manager of the Special Alkalies and Cleansers Dept. in New York.

* * *

Allan Hyer, Vice-President of Bagley & Sewall Co., Watertown, N. Y., has been appointed Consultant to the New Facilities and Equipment Branch of the Pulp, Paper, and Paperboard Div. of the National Production Authority. He will advise the Division with regard to pulp and paper mill machinery and related facilities.

* * *

A new Company to be known as Norton Behr-Manning Overseas, Inc., has been announced. This Company will handle all the export business and direct the subsidiary plant operations of the Norton Co. and the Behr-Manning Corp. throughout the world. Headquarters will be in Worcester, Mass.

* * *

Albert H. Adams, with headquarters at South Portland, Me., recently became the New England representative of Bauer Bros. Co., Springfield, Ohio. Mr. Adams, a graduate Chemical Engineer of the University of Maine, was formerly a Chemist for the Congoleum-Nairn Co. in their Cedarhurst, Md., felt mill.

* * *

The International Nickel Co. (Dept. EZ), 67 Wall St., New York 5, N. Y., has issued a 36-page bulletin entitled Engineering Properties of Applications of Ni-Resist.

* * *

Oliver United Filters, Inc., 33 W. 42nd St., New York 18, N. Y., has issued Bulletin 10-G, Filters for the Process Industries. It briefly outlines the features and applications of 21 of its filter types.

* * *

The General Electric Co. has announced the formation of six new operating divisions. These include the Turbine Div. and the Motor and Generator Div. at Schenectady, N. Y.; Transformer and Allied Products Div. at Pittsfield, Mass.; Measurements and Industrial Products Div. at Lynn, Mass.; Switchgear and Control Div. at Philadelphia, Pa., and the Component Products Div. at Fort Wayne, Ind.

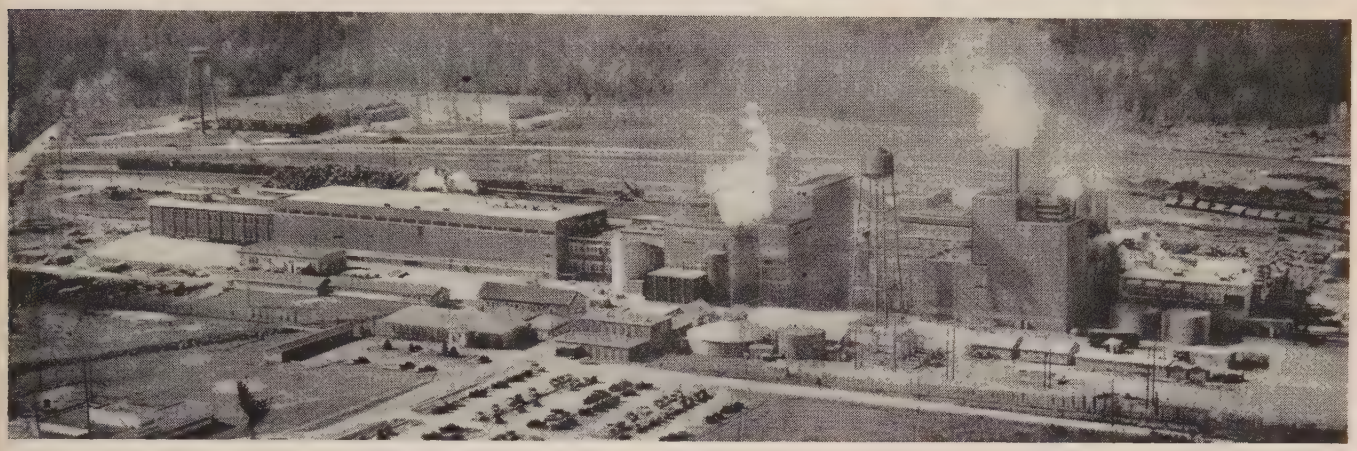
Nearly $2\frac{1}{2}$ million of General Electric equipment has been order by the St. Joe Paper Co. as part of an expansion program designed to increase kraft board production at its Port St. Joe, Fla., mill by 850 tons a day.

The expansion, expected to cost more than $20 million,

Again and again . . .

RUST "Know how"

IS EMPLOYED TO DESIGN AND CONSTRUCT NEW PULP AND PAPER MILLS AND TO MAKE OLD ONES MORE EFFICIENT



The original 200 ton Kraft pulp and paper mill facilities for Crossett Paper Mills, Crossett, Arkansas, were built by Rust in 1936–38. Rust has recently designed and is now completing additions that will practically double the output.

60 ton per day felt mill for Bird & Son, Inc., Shreveport, La., designed and constructed by Rust in 1949–50. A new contract calls for doubling the capacity.

Pulp Washing Plant and Digester Building Addition are part of a major program for West Virginia Pulp and Paper Co., Covington, Va.

RUST experience with both sulphate and sulphite processes repeatedly has been put to work in design and construction by mills manufacturing pulp, paper, wall board, felt and insulation materials. These facilities account for more than 1,000,000 tons of annual production. Rust "know how" is also utilized in such allied activities as bag and paper box factories, bleach plants, etc.

COMPLETE PAPER MILL SERVICE

Service includes ENGINEERING AND SURVEYS: by-product process design; plant design; power, water and waste disposal surveys; wood yard facilities . . . CONSTRUCTION: new plants and auxiliaries or modernization and additions to existing facilities including general construction, piping, and—through a subsidiary—electrical work . . . SPECIALTIES: refractory and acid-proof linings; chimney inspection, repair and erection; equipment and machinery erection; reinforced concrete storage bins; waterproofing of concrete structures.

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will center around installation of a new 236-inch fourdrinier operating over a 400 to 2000-f.p.m. speed range, and a new regenerative tension winder. Both machines will be supplied by the Pusey & Jones Corp. of Wilmington, Del., and will be driven and controlled by G.E. equipment.

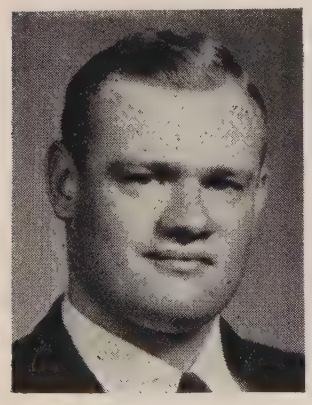
Power demands will be met by two G.E. turbine-generator sets, one rated at 10,000 kw. and the other at 12,500 kw. A G.E. multiple-generator sectional drive will be used for the paper machine. This drive will include seventeen d.c., 1150-r.p.m., separately ventilated motors ranging from 60 to 500 horsepower; four auxiliary motors for the fourdrinier section; three motor-generator sets, each driven by a 1250-horsepower synchronous motor, and electronic amplidyne control for each drive section.

The 226-inch, 5000-f.p.m. winder will utilize two 250-horsepower, d.c. motors and a 250-horsepower braking generator. G.E. also will supply metal-clad switchgear, 16-unit substations ranging from 1000 to 3750 kva., and a 10,000-kva. bus tie transformer.

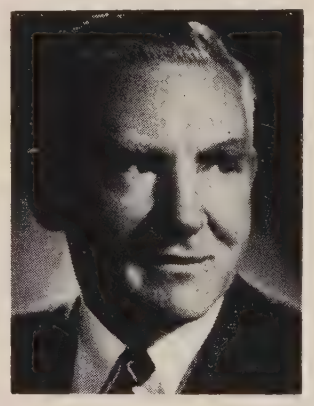
The increased output of kraft board will be used by the St. Joe firm in its manufacture of boxes. The new facilities are expected to be in operation by the Fall of 1952.

* * *

Frank Clawson has been appointed Sales Representative of the Draper Brothers Co., Canton, Mass., makers of the Draper felt. He will cover midwest paper mills with L. H. Breyfogle and L. L. Griffiths, Jr. Mr. Clawson was educated at Ohio State and Miami Universities and was recently in the employ of the Sutherland Paper Co. in Kalamazoo, Mich.



Frank Clawson, Draper Brothers Co.



Thomas E. Moffitt, Hooker Electrochemical Co.

* * *

Thomas E. Moffitt has been appointed Works Manager of the Hooker Taconia, Wash., plant succeeding John D. Rue who has retired under the Company's pension plan. Dr. Rue now resides at 516 Yakima Ave., Tacoma 3, Wash. Mr. Moffitt is a graduate of Cornell University and has been associated with Hooker Electrochemical Co. since 1930. Dr. Rue was with the Company since 1931. For eleven years he was Sales Service Engineer at the Niagara Falls plant, being in charge of service work primarily, for the pulp and paper industry. From 1942 to 1946 he was Assistant Chief Engineer until his transfer to Taconia. Before joining the Hooker organization he was Chief of the Pulp and Paper Section of the Forest Products Laboratory at Madison, Wis., Director of Research for the Champion Fibre Co., Canton, N. C., and served as Engineer for the News Print Service Bureau in New York. His education as a Chemical Engineer was obtained at Princeton University, Heidelberg University, Zurich Polytechnikum, and the University of Michigan. He served as Associate Professor of Engineering at the University of Michigan.

* * *

Bjarne Klaussen has been elected Executive Vice-President of the Hooker Electrochemical Co., Niagara Falls, N. Y. Mr. Klaussen is a graduate of the University of Oslo in Norway and joined Hooker in 1916 as a Research Chemist.

* * *

Don L. Hinman has been appointed Assistant Manager of the Johns-Manville Transite Pipe Dept., New York, N. Y. Mr. Hinman succeeds E. A. Phoenix who was recently appointed to the Johns-Manville post of Manager of Market Surveys.

* * *

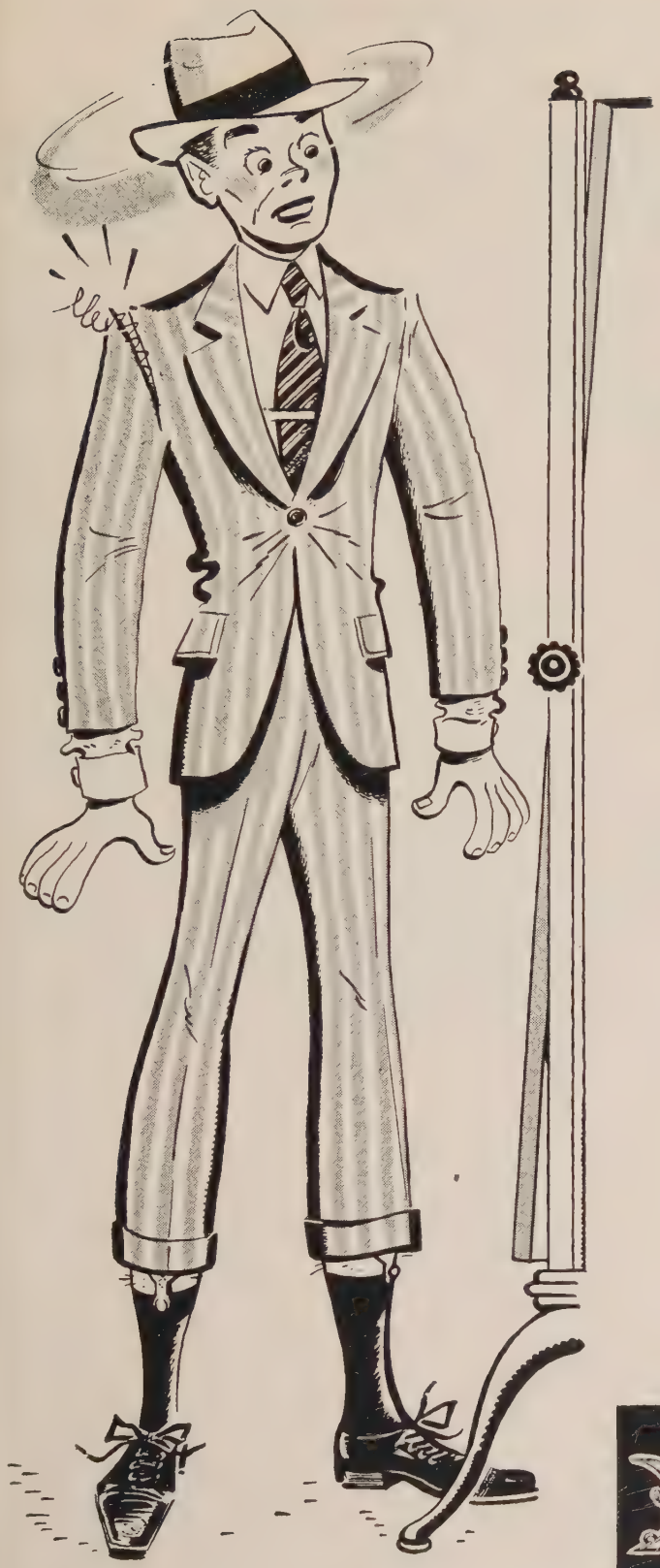
Spencer H. Hellekson, Superintendent of the Milwaukee, Wis., plant of the Paper Makers Chemical Dept. of Hercules Powder Co. will move to the department's Savannah, Ga., plant as Assistant Manager. The Savannah plant is the largest operated by the company. Keith Martin succeeds Mr. Hellekson at Milwaukee.

Hercules Powder Co., Wilmington, Del., has issued a new booklet describing the simplified automatic emulsifier for rosin size. A feature of the booklet is a four-color diagrammatic flow sheet showing the flow of rosin size through the processes.

* * *

The photograph shows Walter J. Bergman, President of the Lily-Tulip Cup Corp., College Point, N. Y., addressing the members of the Netherlands Paper and Board Packaging Mission who recently visited the plant. The members of the mission were: Frederick Bloemendaal, Secretary, Netherlands Packaging Society; Johannes W. Boon, Rintje de Boer, Chemical Engineer, N. V. Ligm en Gelatinefabriek, Thomas a de Hens, Desigmor, Arie de Zeeuw, Manager, Z. de Zeeuw Co., Johannes Eykel, Manager, N. V. Neparofa, Carnelis Hillenius, Director, Research Institute for Packaging, William Jesse, Consultant, Dirk Miedenia, Cartonnagefabriek D. Miedenia, Adrianus Krael, Manager, Cartonnagefabriek Holland, Jacob F. Tennissen Van Mauen, Director, N. V. Apeldoomse Cartonnagefabriek Zroenlo, and Rinse Sinia, Packaging Engineer, Algemene Kunstzijde Unse, N. V. The mission visited container and paper mills in New Jersey, Missouri, Wisconsin, Illinois, Michigan, and Massachusetts.

The President of the Lily-Tulip Cup Corp., Walter J. Bergman, greeting members of the Netherlands Paper and Board Packaging Mission during their visit to the company's offices and plant



Not everybody takes a "Regular"

As a matter of fact, some men can't find a really perfect fit unless they have their suits tailor-made.

It's that way with the supplies you buy, too. For instance, we have a complete line of standard starches and other corn products for paper mill use; but we are *also* set up to provide you with any *special* formula or product, *tailor-made* to your specifications.

And . . . standard or special . . . you'll want to buy from a company like Anheuser-Busch, whose reputation for products of highest quality, uniformity and dependability is as dominant in the paper industry as it is with retailers and consumers all over the world.

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LOCAL SECTION ACTIVITIES

Reports of Meetings, Personnel and Events

Lake States

The Lake States Section met at the Hotel Conway, Appleton, Wis., on Sept. 20. Alan Adrian of the Neenah Paper Co., presided as Chairman.

In addition to the regular membership about 40 foreign scientists were present. The total attendance was high, numbering about 300.

The guests were greeted briefly by Mr. Adrian, K. P. Geohegan, President, and R. G. Macdonald, Secretary of National TAPPI.

The first speaker, who was introduced by R. J. Seidl of the Forest Products Laboratory, Madison, Wis., was W. E. Cohen of Australia. Dr. Cohen is Senior Principal Research Officer, Wood Chemistry Section, Division of Forest Products, Commonwealth Scientific and Industrial Research Organization. He is also a member of the FAO subcommittee on wood chemistry. He is the author of many technical publications. The subject of his talk was "Cooperative Research on Pulp and Paper in Australia."

Dr. Cohen began his talk by bringing a welcome to American TAPPI from the Australian Pulp and Paper Industry Technical Association, of which he is President. He gave the background to the rather unique technical cooperation between the Australian Pulp and Paper Industry and the Government Division of Forest Products in fostering research of special interest to the industry.

Australian forests are predominantly hardwoods, mostly of the genus eucalyptus. Consequently, for a pulp industry to occur at all meant to regard hardwoods as the raw material. The acute shortage of pulp during the 1914 war emphasized Australian dependence on forest supplies and stimulated development of the pulp industry at that time. There were then five paper mills, but almost no men trained in the industry who could contribute to the conversion of eucalyptus to a useful pulp. The forest authorities plus private capital formed a research team; the scope of this research was broadened and later became the Council for Scientific and Industrial Research. It is interesting that in the early stages there were as many technical men outside the industry working on the subject as there were within the industry. Later, other industries, particularly the metallurgical and publishing, participated in the development. Most of the original research group moved into the industry itself and under their influence the mills made rapid technical progress. Dr. Cohen was with the original research group, but continued in government-sponsored research, which then changed direction to emphasize wood chemistry and other basic studies. He was therefore the link between the original research team and the Wood Chemistry Section.

Another important and highly significant factor which has influenced the cooperative research was the appointment to executive positions in the pulp industry of men from the metallurgical industry, because with them came a genuine appreciation of the value of technical control and research.

In 1928 the original steps were taken to form the Division of Forest Products under I. H. Boas, who was the original planner of the pulp and paper work. Industry looked to this group for basic research on eucalyptus. In 1934 was conceived the first cooperative agreement between the Division of Forest Products and the Australian Paper Mfgr., Ltd. This concern contributed both man power and funds to study problems of mutual interest. In 1938 the Australian Newsprint Mills Ltd., and Associated Pulp & Paper Mills Ltd. also joined the cooperative agreement.

Each year a Pulp and Paper Cooperative Research Conference is held to report results and review problems of common interest. Published proceedings of the conference were originally restricted to Australia, but now by agreement they are sent to selected organizations in many countries.

Dr. Cohen presented typical problems undertaken as part of this cooperative work and outlined the steps taken toward solution. As in most research, one problem led to another, and the research studies were modified to accommodate each problem in order of its importance. As examples, Dr. Cohen presented results of work on the calibration of the Lampen mill and the results of studies of the Marx-Elmendorf and the Thwing-Elmendorf tear testers. He also showed interesting slides on the effect of electrolytes on properties of pulp and paper. Some of this work was recently published in American trade journals.

The second speaker, also a foreign guest and a distinguished scientist, was Borje Steenberg of Sweden. He was introduced by J. Richter Salvesen of Marathon Corp. Dr. Steenberg who spoke on the "Influence of the Paper Machine on Paper Properties," has been Director of Research, Paper Technical Department, Swedish Forest Products Research Laboratory, since 1944; Head, Department of Paper Technology, Royal Institute of Technology, Stockholm, since 1949, and Dean, Graduate School of Chemistry, Royal Institute of Technology, since 1950. He has published about 50 papers on x-ray crystallography, absorption, and paper technology.

Dr. Steenberg gave a most interesting and stimulating talk on his subject. Emphasis was placed on an analysis of the viscoelastic properties of moist and dry paper and the sensitivity of paper to the various stresses applied by the paper machine. He showed that the stiffness and unidirectional strength of paper were caused to a greater extent by applied stresses in the machine direction than they were by actual orientation of fibers. Fiber orientation occurs but is not as pronounced or important as ordinarily supposed. Fiber orientation can be determined by adding colored fibers to a furnish and making a count on the sheet at the wire. This would show a considerable orientation at the wire side of the sheet and a much lesser effect on the top side of the sheet. The fact that orientation is not great on the top side indicates that the slice does not have much effect on the isotropy of the sheet. Several effects can occur to cause directional properties after the sheet leaves the wire, however. It was shown that a tension or stress applied by the machine draws or by shrinkage can cause a considerable increase in strength and stiffness in the machine direction of paper. The use of a simple tensile test in two directions on a paper as a means of measuring fiber orientation is therefore misleading.

Dr. Steenberg gave an interesting graphic presentation of how the modulus of elasticity of a paper in the machine direction could increase with tension applied at numerous places along the length of the paper machine. To sample papers at almost each press and drier roll to make such studies required a large crew working with military precision. Tests on the samples showed a progressive increase in stiffness right on through the machine to the calenders.

The stretching effect on the paper machine could not have caused a great fiber orientation that did not previously exist

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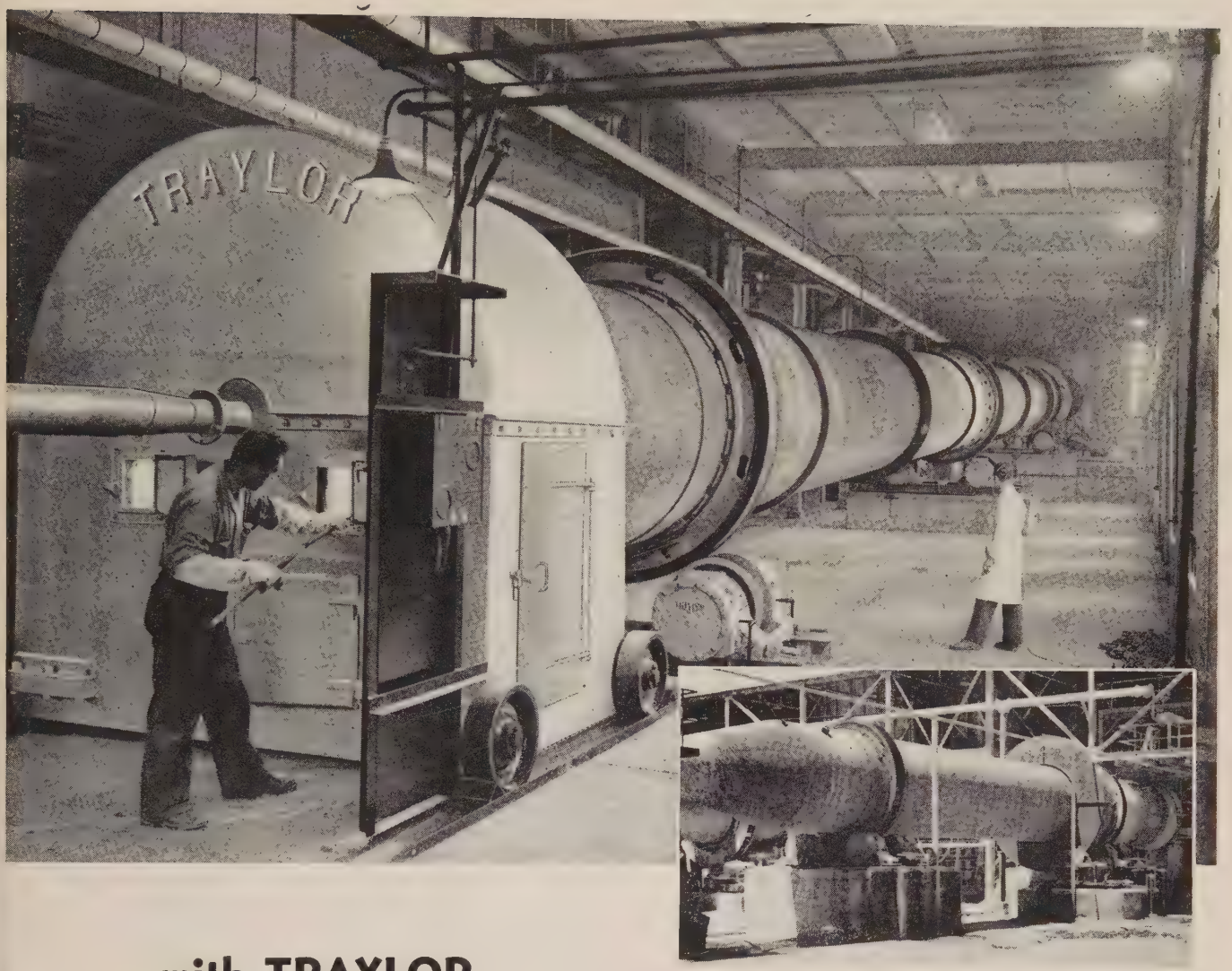

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Lake States meeting head table: H. W. Rowe, Nekoosa-Edwards Paper Co.; K. P. Geohegan, Howard Paper Mills; R. J. Seidl, Forest Products Laboratory; W. E. Cohen, Australian Forest Products Laboratory; A. P. Adrian, Neenah Paper Co.; Borge Steenberg, Swedish Forest Products Research Laboratory; J. R. Salveson, Marathon Corp.; R. G. Macdonald, TAPPI; and L. A. Moss, Whiting Plover Paper Co.

in the sheet because the total elongation is not great enough. However, Dr. Steenberg had made a mathematical analysis to show that a slight elongation could in fact have caused a realignment of small fibrils or fiber fragments and that this may be responsible for the high unidirectional strength. At least this is a theory from which to reason further.

The value of the stress-strain curve as a means of analysis of fundamental properties of a paper was emphasized. By this tool many basic things can be learned about paper. For instance, in "mechanical conditioning" of paper the maximum stress ever applied to the sheet will be reflected in its stress-strain curve. This was described as a "memory effect" of paper.

As further evidence of the effects of stresses during drying on properties of paper, Dr. Steenberg showed that by taking a sample from the machine wire and clamping it in the cross-machine direction but permitting it to contract freely in the machine direction, the cross-machine stiffness could be increased to exceed that in the machine direction. Another interesting experiment is in drying a handsheet (with no predominant grain direction) under conditions of restraint in one direction but with freedom to shrink in the other direction; the direction in which restraint occurred will later yield a stiffness several times that in the other direction.

Dr. Steenberg discussed how properties of paper vary across the width of paper machines. Interesting experiments on this were made by cutting the sheet at intervals across the width of the sheet and drying the samples under conditions of no restraint. The edge effect on the machine is shown to be not necessarily related to variable drying conditions from edge to center, but rather to shrinkage effects and restraints of the sheet against the drier surface.

Dimensional movement of paper with moisture changes was described as a "thawing-out" of "frozen-in" stresses in paper.

Chicago

The general stability of the paper industry, coupled with its recent expansion and modernization, places it high on the list of those industries presenting sound investment risks. This view was expressed by A. Newell Rumpf, Vice-President of the Harris Trust and Savings Bank, Chicago, in an address before the opening session of Chicago TAPPI's 1951–52 season. Seventy-six members and guests attended the dinner meeting.

Officers for the current year are as follows: the Chairman is V. V. Vallandigham, Kelco Co.; Vice-Chairman, A. Deutsch, Container Corp of America; Secretary, C. Krebs, Atlas Boxmakers, Inc., and Treasurer, J. R. Fulghum, Socony-Vacuum Oil Co. The group meets on the third Monday of each month at the Chicago Bar Association quarters in Chicago.

Declaring that the banker's interest naturally lies in the financial welfare of the firm securing a loan, Mr. Rumpf noted that the paper industry has in the past few years undertaken expansion plans equaled by few industries in the United States. "Since 1945," he declared, "the productive capacity of the paper industry has increased from 19,400,000 tons to a rated capacity of 25,500,000 tons in 1950. Current figures indicate that the capacity build-up in the steel industry during the same period has amounted to 8,700,000 tons. Percentagewise, the paper increase, amounting as it does to 31.4%, compares most favorably with an increase in steel capacity of 9.1%."

That a successful bank must necessarily determine the risk involved before granting any industry a short or long-term loan is obvious, Mr. Rumpf continued. He listed four considerations taken by bankers in their deliberations and decisions as to the stability of any firm: (1) character and ability of management; (2) financial assets; (3) operations, and (4) prospects. Character, he declared, is determined from past record and history, while ability is a matter of opinion and appraisal of individuals, with the operating record a yardstack of measurement.

"If we could take a financial statement," he went on, "and by analyzing the figures alone assure ourselves regarding the standing and goodness of a risk, the matter would be a simple procedure." The speaker explained that certain portions of a financial statement are not considered of value in determining a business's soundness. For example, fixed investments, while necessary to industry, are not given much weight by a short-term lender, except possibly as a basis of analysis to assure that such investment is not out of proportion to the capital investment. In addition, nonrealizable assets—consisting generally of good will—are not adequate basis in themselves for granting a loan to industry.

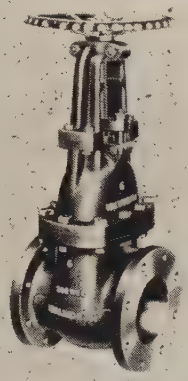
"We are naturally interested in the earning record (operations), and examine the profit and loss statements for a period of years," Mr. Rumpf declared. "If the record of an individual company runs counter to the industry trend, a red flag appears. . . . Other factors under this heading include plant efficiency, banking performance and trade record, overhead expense, organization morale, and labor relations."

High on the list of considerations to be made by the prospective lender, he said, is the degree of essentiality of the product and the competitive position of the company (prospects). A projection of operations, intelligently conceived, is a valuable tool to the credit analyst. Here we must also examine the capital expenditures or plant expansion contemplated

Left to right: A. Newell Rumpf, Harris Trust Co.; P. J. Trucano, Morris Paper Mill; V. V. Vallandigham, Kelco Co.; G. A. Zinkil, Central Fibre Products Co.; M. G. Kuhlman, Fleming & Sons, Inc.; J. R. Fulghum, Socony-Vacuum Oil Co.; and C. Krebs, Atlas Boxmakers, Inc.

Walworth

Valves and Fittings



WALWORTH No. 725FS OS&Y, Flanged, Special Alloy Wedge Gate Valves were developed especially for the pulp and paper industry. They are available in sizes from 2 to 12 inches for 200 pounds, and 14 to 24 inches for 150 pounds, non-shock service.

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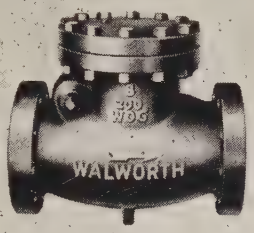
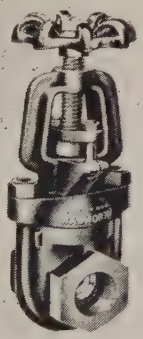
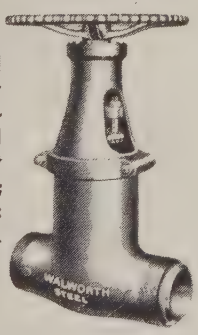
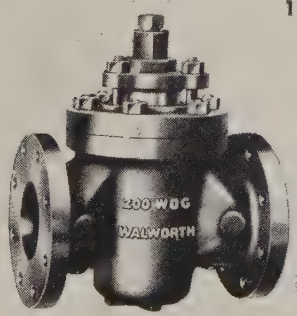




WALWORTH No. 716 is an OS&Y, Saddle Style, Wedge Gate Valve having body, bonnet, and wedge of Ni-Resist. The seat rings and stems are of 18-8 stainless steel. These valves are available in sizes ½ to 2", and complement the No. 725FS valves in the smaller sizes.

WALWORTH Pressure-Seal Cast Steel Gate Valves exemplify the greatest improvement in high-pressure, high-temperature valve design. The internal pressure keeps the body-to-bonnet joint tight. Series 600: 1½" and larger; Series 900: 3" and larger; Series 1500: 1" and larger.





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and be assured of the financial ability to conduct this expansion. The further development of the product and the potential expansion of sales at a profit are, while intangible, essential to the study.

Speaking of the stability of the paper industry as a basis of the loan banker's viewpoint, Mr. Rumpf declared that last year printing and publishing consumed an estimated 10,000,000 tons of paper (including imported newsprint). An additional 13,500,000 tons were used in packaging, while 1,500,000 tons were consumed in those papers dealing with sanitary functions. And almost 4,000,000 tons were utilized in building, mechanical, and other paper classifications.

"The paper industry will be producing almost 7 billion dollars worth of goods this year," Mr. Rumpf continued. "Employment is running currently at 209,000 workers, exclusive of salaried individuals and those employed in the woods, with the present annual payroll approximating $765,000,000." He pointed out that probably 1,000,000 people with an annual payroll of close to three and one-half billion dollars are directly dependent on the industry.

"As far as total assets are concerned reliable sources indicated an industry figure of close to 5 billion dollars at the end of 1949. In all probability, new capital and retained earnings invested in property have increased this figure to close to $5^1/_4$ billion at the present time. This is a substantial increase over the 2.97 billion at the end of World War II." According to the speaker, the increase is due in part to the deferred maintenance, modernization, and improvement accumulated during the war years and the bunching up of plant and equipment requirements.

"The growth in production since 1945 has been equally as rapid. In 1945 a total of 17,400,000 tons was produced, 22,100,000 in 1948, 20,300,000 in 1949, and a record 24,300,000 tons last year. According to primary estimates," he declared, "total production for the first six months of 1951 was 13,700,000 tons. . . . It is thus easy to see that it will be possible for the industry to produce over 27,000,000 tons in 1951, provided raw materials are adequate.

"Capital requirements for entering into the industry are very large. Pulp mills run in the neighborhood of $70,000 per ton capacity, and a 200 to 300-ton mill is required in most instances for economic operation. The proposed National Container Co. plant in the South is expected to run around $23,000,000 for a 500-ton kraft mill. You certainly can't go into this business with pennies."

Speaking of the investment required in the paper industry, Mr. Rumpf declared that the large capital outlays plus substantial lease obligations for the fully integrated operator with access to timberlands are the principal fixed costs involved. He added that the industry has the largest investment cost per worker of any industry in the country. Profits vary considerably with the rate at which wood mills are operating. It has been estimated that fully integrated mills must

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operate at least 80% of capacity for profitable results. Non-integrated firms can probably operate at lower levels due to some freedom from leasehold costs.

Discussing consumer demand in the paper industry, Mr. Rumpf noted that on a basis of orders received since mid-1949 it can be established that production has not been sufficient to meet consumption; and, therefore, it appears that paper production in general can justifiably be maintained at high levels. However, in view of the fact that production has exceeded basic demand for the most part since mid-1949, it would seem significant that an ultimate adjustment is in the offing. Therefore, the conclusion must be that paper production should continue at high levels over the short term, but that, unless a significant change takes place, the basic demand in the form of an upward spurt of paper production might have to level off within the next year or so.

In commenting on cost-price relationships in the industry, Mr. Rumpf said that the squeeze which results during a period when prices are controlled provides greater stability to paper selling prices than to related wages and material costs. "This tends to be offset during such periods," he said, "by reasonably high production activity, and consequently fixed costs are not overly burdensome. This presents a problem for the industry in that costs appear to rise more rapidly than selling prices.

"There appear to be few, if any, definite trends in profit margins for paper industry operators. The margins of the major companies for the most part have fluctuated somewhat in line with sales volume." Low sales volume in 1938, 1945, and 1949, Mr. Rumpf explained, were all accompanied by lower than average margins for most companies. Peak margin years, on the other hand, were in 1941 and 1948, both years of high paper production and sales.

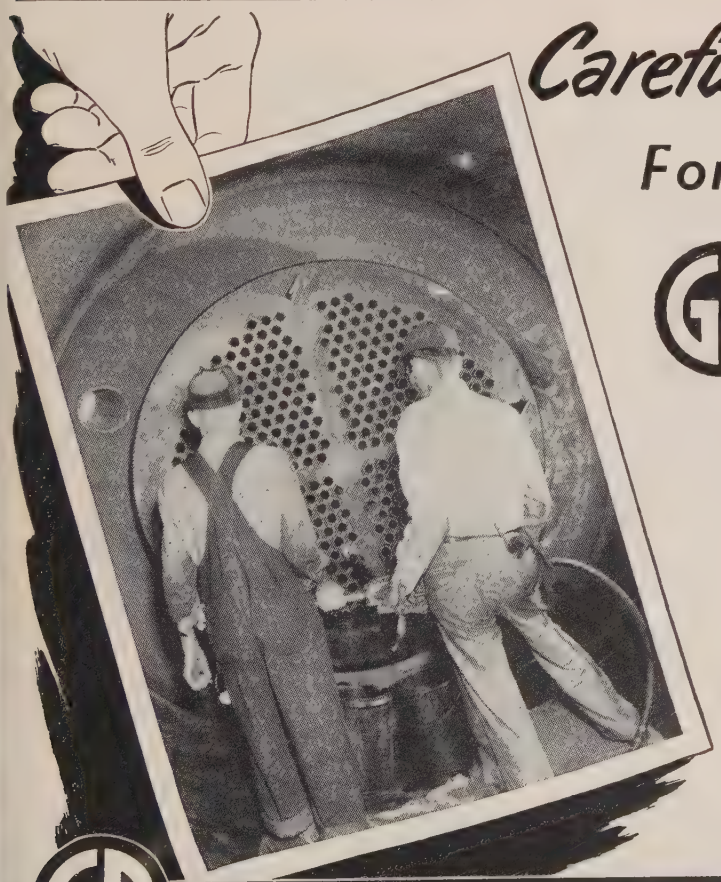
"The rate of return (after taxes) on stockholder investment in paper and allied product firms," the speaker noted, "compares favorably with other industries. A study made by the Federal Trade Commission reveals that 103 corporations showed 9.6% in 1940, 21.1% in 1947, 18.2% in 1948, 12.1% in 1949, and 16.1% in 1950. Of the 25 industries considered, only industrial chemicals, office and store machines, motor vehicles, motor vehicle equipment, and electrical machinery and equipment showed a better rate of return than the paper industry. It appears that the industry and its stockholders are in good company."

In conclusion, Mr. Rumpf recalled one element of profit usually forgotten by industry and consumer alike. "It is well known," he said, "that you have to sell your product for more than it costs you or you go 'busted.' That difference goes by the nasty name of 'profit.' If the product you sell isn't worth a lot more to the customer than what he paid for, it is the customer's profit. And the customer's profit is industry's profit."

October 15th Meeting

Clint Royce really packed them in at the October dinner meeting of the Chicago Section held on the fifteenth at the Chicago Bar Association rooms. Two hundred ten members and guests were "steeped" in the latest authoritative information on military packaging for hours without a whimper.

Mr. Royce, the Head of the Packaging Section, Office of Navy Material, was introduced by Chet Spaulding of Tested Papers of America who was largely responsible for arranging the evening's session. Mr. Royce then presented the military film "Pack It Right" showing graphically and so convincingly the right and wrong way to package. The film is a collection of scenes from World War II. It showed the handling and storage of war material, machine parts, rations, clothing, ammunition, lubricating oil, cement, instruments, blood plasma, soap, medicinals, etc., starting from the shipping points on the mainland and carrying forward to field supply depots. The climate of the South Pacific area, steadily hot,



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Left to right: J. R. Fulghum, Socony-Vacuum Co., A. L. Magnuson, Kelco Co.; C. Spaulding, Tested Papers of America; C. K. Royce, Office of Navy Material; V. V. Vallandigham, Kelco Co.; Charles Krebs, Atlas Boxmakers, Inc.; and M. W. Snover, Williamson Adhesives

intensely humid, soon demonstrated packaging deficiencies that could hardly have been foreseen. Forward supply depots were frequently no more than makeshift shelters with open sides. Tropical rains and salt spray, borne on heavy winds, lashed through these improvised shelters, piled high with packaged material. A heavy percentage of material of all types was in unusable condition when opened, quite often when sorely needed. Metal cans rusted through and the contents emptied out on other material stored underneath. Fabrics and leather deteriorated with mold. Damage from liquid water, corrosion, and handling caused losses of magnitudes hard to comprehend.

The film further demonstrated that good use was later made of the experience which had been gained the hard way. Through the efforts of military packaging personnel and the never failing ingenuity of American industry, packaging improvements were instituted where deficiencies had previously shown up. By the war's end, a much higher percentage of package units were getting to the fighting areas in usable condition.

At the conclusion of the film, Mr. Royce discussed the situation in packaging as it existed at the end of the war and as it exists today. He spoke highly of the efforts of the paper industry. For instance, he said that 19 days after the request was made by the military, industry brought forth V-board for packaging.

Flexible barriers, he said, may be classified as follows: (1) waterproof, (2) greaseproof, (3) combination of 1 and 2, and (4) water-vaporproof. By waterproof is meant only sufficient barrier to protect intermediate packaging materials against liquid water. There are hot-melt materials for water and water-vapor protection which have been developed since the last war. Vapor phase inhibiting materials show promise, he said, and are now covered by specification. Bids are being called for rather slowly, until such time as this material has been thoroughly tried, he said.

Mr. Royce declared that present military planning calls for barrier materials which will perform in low temperatures as well as high. The range of performance is now –65 to 165°F.

There was serious concern during the last war concerning availability of packaging materials, he said. If we had been compelled to invade the Japanese mainland, we would not have had enough packaging materials to do it. There was only a 7% cushion between consumption and productive capacity on kraft paper, he said, and only a 4% cushion on container board.

Mr. Royce stated that a joint Army, Navy, Air-Force Manual will soon be issued to assist would-be contractors and contractors in all phases of military procurement. Adequate announcement will be made as to when it will be available.

The contractor at all times should be sure that the bid request shows in detail the packaging requirements. If the

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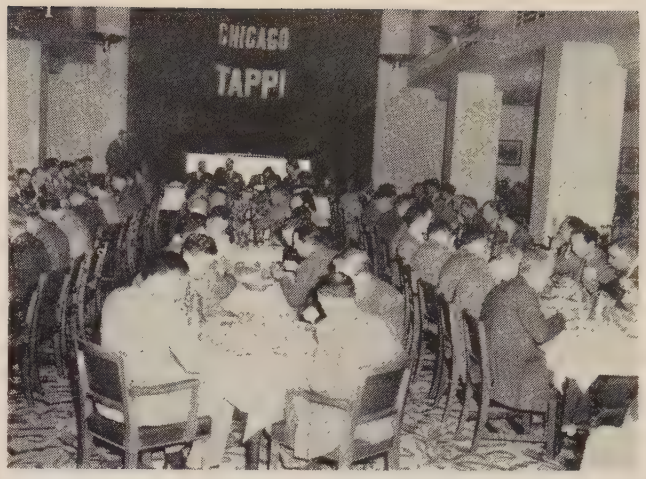
bid request does not do so, the contractor should submit his own proposal on packaging for acceptance before starting on the fulfillment of the contract, Mr. Royce said.

At the conclusion of his forthright talk, Mr. Royce was deluged with questions by an attentive audience. Typical questions and answers follow:

Question: What replaces asphalt in multiwall bags?
Answer: Polyethylene.
Question: Are multiwall bags mixed indiscriminately with all types of freight, or handled separately?
Answer: They are not normally mixed. An interesting sidelight is that each man in the fifth wave on beach-head landings carried in a 46-pound bag of cement. Cement was so urgently needed in the consolidation of the landing. Multiwall bags are particularly well adapted to palletizing with glue binding.
Question: Where does the government stand on approval of V.P.I. materials?
Answer: The specifications have a dual requirement: (1) passing of a cycle test and (2) field performance of one year. A number of materials have passed except on the second item on which sufficient time has not yet elapsed. There is nothing to prevent the services from using V.P.I. paper if specifically approved by the procuring agency.
Question: What is the condition of arrival and storage in supply depots in Korea as against last war?
Answer: About the same. The Army just brought back an observation team who reported arrival and storage conditions good.

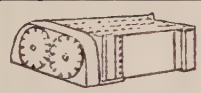
It became necessary to cut off the question period in order to carry out the balance of the scheduled program. Panel discussion leaders had set up shop in different sections of the suite. Exhibits and samples were on display, and competent leaders ready to answer questions. Members of the audience attended whichever panel suited the individual interest. Many visited several panels. Discussions at these panels were lively and sincere. An extremely large percentage of the men attending the dinner and Mr. Royce's talk stayed to the breakup of the panel discussions at a late hour.



Chicago Section group at the military packaging meeting

The following men, each well qualified in his own field, conducted the panel discussions:

SECTION I: Greaseproof—Greaseproof Moisture Vaporproof Barriers—Bags—Sealers—involved in methods 1-A1,1-A 2, 1-A3, and 1-A8.
Panel: J. G. Surchek, Dearborn Chemical Co.; Walter Newton, Arvey Corp.; Heinz Loeffler, Exeter Paper Co.; Wm. Burgess, H. P. Smith; P. O. Pedersen, Cadillac Products, Inc.; Wm. Troph, Doebeckman Co.
SECTION II: Waterproof Barriers—Case Liners and Sealers.
Panel: Ralph Knapp, Thilmany Pulp & Paper Co.; Irv Stoeller, Fibleco Illinois Corp.; David Bookshester, Paisley Products Co.
SECTION III: Volatile Corrosion Inhibitor Treated Packaging Materials.
Panel: John LeBolt, Cromwell Paper Co.; Carl Salzman, Non-Rust Chemical Corp.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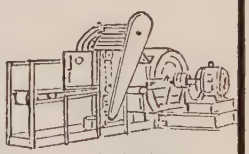
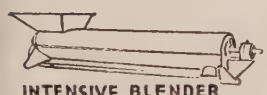
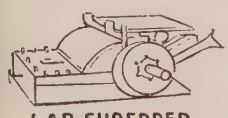
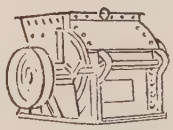

PAPER SHREDDER


INTENSIVE BLENDER


LAP SHREDDER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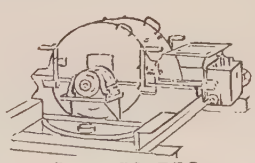
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Hot Melts are applied by equipment which operates on the waxing machine principle,—but usually at much higher temperatures. We do not know of a satisfactory method of applying hot melts to sheets. Sometimes hot melt compositions can be dissolved in a solvent and applied to sheets by gravure or the varnishing machine method.

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HEAT SEALING LABELS carrying a backing of PROXMELT adhesive are attached with heat and pressure at high speed to paper, cellophane, glassine, Pliofilm, Saran, foil, etc.

HEAT SEALING BAGS, paper, glassine and parchment are produced with a strip of PROXMELT inside the bag mouth. Such bags are closed automatically on filling machines equipped with heat sealing attachments.

SET-UP BOXES are assembled and stayed on machines which thermally tack the corners with heat sealing PROXMELT coated "gummed" tape.

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SECTION IV: Tape and Sealed Rigid Metal Containers.
Panel: Bill Knox, Knox & Schneider; Roy Sullivan, Inlander-Steindler; Ed Katz, Greenwood Packaging; Wm. Givens, Mystik Adhesive Products; Ed Greenman, Mid-States Gummed Paper Co.

The meeting on Nov. 19 will consist of a panel discussion on greaseproof Papers and Films. Robert Erickson of the Erickson Research Laboratories, Kalamazoo, Mich., will discuss "Formulations"; A. T. Luey of the Sutherland Paper Co., Kalamazoo, Mich., will talk on "Theories of Coating Applications"; L. E. Whittemarl of the Bakelite Corp., New York, N. Y., will speak on "Polyethylene Liners"; and Martin L. Downs of the Thilmany Pulp & Paper Co., Kaukauna, Wis., will talk on "Glassine Papers and Laminations."

WARREN R. PRICE,
Publicity Committee

Delaware Valley

The Delaware Valley Section started off its 1951–52 season with a mill visit at the Miquon, Pa., mill of W. C. Hamilton & Sons at 3:00 p.m. on Friday, Sept. 21. About 75 members and guests were conducted on guided tours in small groups through the seven-machine mill manufacturing a wide variety of fine papers.

The evening dinner meeting was held at the Engineers Club, Philadelphia, at 6:30 p.m. with about 90 members and guests attending. Section Chairman A. S. Erspamer of P. H. Glatfelter Co., Spring Grove, Pa., presided.

Chairman Erspamer opened the meeting by welcoming the members and friends to the Section's 20th Anniversary Year and announced that in keeping with the Anniversary the following program for the year had been drawn up.

Oct. 25—"Technical Control of Machine Production" by D. H. Nethercut, Scott Paper Co., Chester, Pa.
Nov. 29—"Color Engineering, Paint for Safety, and Efficiency of Paper Production" by L. E. Whitmayer, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.
Jan. 24—"Development of New Products for the Paper Industry" by A. L. M. Bixler, Riegel Paper Corp., Milford, N. J.
Mar. 27—20th Anniversary Meeting, "Historical Background of the Section" by E. J. Albert, Thwing-Albert Instrument Co., Philadelphia, Pa.
"Development of TAPPI and Local Sections" by K. P. Geohegan, Aetna Paper Div., Howard Paper Mills, Dayton, Ohio
Apr. 24—"Mill Management" by H. H. Hanson, W. C. Hamilton & Sons, Miquon, Pa.
May 22—"E. J. Albert Award Program," Presentation of Prize Papers

Elmer Mitchel, on behalf of the Superintendents Association, invited all TAPPI members to the Superintendents Association meeting at Pocono Manor on Sept. 28 and 29.

The Award Committee Chairman, Fred Loser, was called upon to explain the Edward J. Albert Award which is to be an annual competition sponsored by the Delaware Valley Section.

This competition has been named for one of the founders of the Section, Past-Chairman, and one of the most active and loyal members of the Section since its inception in 1931, Edward J. Albert.

The award competition consists of the presentation of papers on original work of a technical nature by young men actively engaged in the paper industry. Since the primary purpose of the competition is to encourage and benefit the younger members of the industry, those in supervisory positions or who have gained maturity through considerable experience, such as technical directors, chief chemists, experienced research chemists, and the like, are not to be considered eligible to participate. The participant may choose his own

subject on some technical aspect of the manufacture of pulp and paper, and associated with some operation, process, or investigation in which he has been concerned in the course of his association with the industry.

The papers will be judged by a committee of five and will be judged on the following points:

1. Planning and resourcefulness exhibited in the execution of the work described.
2. Organization of the paper.
3. Presentation of the paper.

The points to be considered are arranged in descending order of their importance.

The Edward J. Albert Award shall be a substantial monetary reward, and in addition a suitably engraved plaque will be presented to the winner. This plaque is to be kept on public display at a place to be determined by the executive committee of the Section.

Each contestant, including the winner, shall receive a suitable token of his satisfactory participation, a copy of Sutermeister's "Chemistry of Pulp and Paper," autographed by the author.

Presentation of the papers by the author in person, announcement of the winner, and presentation of the award shall be at the Section meeting on May 22, 1952, to be held at the Engineers Club, 1317 Spruce St., Philadelphia, Pa.

The meeting was then turned over to the Program Chairman, Harold C. Brill, who announced the program for the night, "Recent Trends in Fourdrinier Machine Practice," to be discussed by a panel of experts representing paper machinery and manufacturers and headed by Romeo Tourangeau, General Superintendent, W. C. Hamilton & Sons, who acted as Moderator. Before introducing the panel, Mr. Tourangeau gave a short opening address with the following comments.

"When I was first approached by your committee to serve as moderator for the discussion here this evening on 'Recent Trends in Fourdrinier Machines,' I was quite enthused as I thought that with a whole paper machine to play with there certainly would be enough material to work with to make the job an easy one. On further reflection, however, I realized that to cover recent trends and practices for a whole machine in one evening would be a pretty large order.

"In checking with several members of your committee and the panel, the consensus seemed to be that the forming or wet end of the fourdrinier and presses would perhaps be of greatest interest. That does not mean that our discussion cannot go beyond the presses. This is your meeting and I am sure that your panel members will be glad to answer any question they can on any part of the machine.

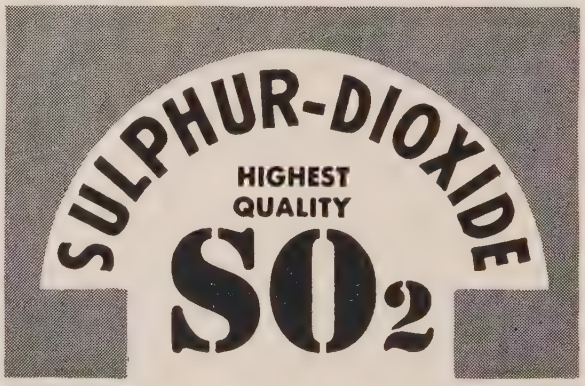
"My observations and remarks will be as brief as possible and will by no means attempt to cover the entire list of recent innovations and improvements on fourdriniers. Rather, they will be intended to merely start the ball a-rolling. I would like to say at this time that any errors or misinformation on my part are not intentional and I will welcome corrections from our panel or anyone else.

"Inasmuch as screening problems are common to all types of machines, let us start with the flow system from the screens to the inlet. This probably should be considered in three parts.

"1st—The method of getting our screen effluent to the headbox.
"2nd—The headbox with the various methods of distributing the stock suspension.
"3rd—The slice or inlet.

"A great deal of progress has been made in recent years in each of the three divisions just named. Through the use of deaerating columns, manifold entrances, and the various means of fiber separation and distribution systems now available, the industry has been helped considerably in overcoming some of the problems attending increased speeds and the demands for uniformity,

Many former users of Sulphur have switched to Sulphur Dioxide, and are finding that Sulphur Dioxide is just as effective and as economical. There are numerous cases in many different industries where this conversion has been made and the results have been most satisfactory. Perhaps Sulphur Dioxide can be just as effectively adapted to your operation. We would be pleased to have one of our representatives consult with you—no obligation to you, of course.



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CALENDER ROLLS

"Through years of research, each one of the manufacturers making stock inlets, and these include the pressure inlets, has developed certain features that have found their places in the extremely varied needs of our industry. Let's hope that our discussion this evening will bring out some of the high lights of these features.

"Moving on to the wire, we find one manufacturer supplying us with a dual breast roll. By using a smaller diameter roll at the top, with the larger conventional roll at a lower level, we get less sag between the breast roll and the first table roll.

"Among us are some who are using the so-called forming boards to accomplish the same purpose, that of eliminating wire sag. In passing, we might mention the various designs now employed in these forming boards. Some are slotted with combination deflectors built in. Others are solid, to retain water rather than removing it. I have seen one, recently, that was drilled and used as a suction box, where it was necessary to remove a great deal of water immediately after flowing onto the wire.

"Very recently the suction breast roll was introduced, ostensibly for the same purpose.

"Getting back to the slice for a moment, it is now possible with one manufacturer's design to adjust both the apron board and top slice lip in a horizontal position back and forth over center of breast roll. This gives the operator an opportunity to adjust for the best flows in extremes of weight.

"Spiral fin-type table rolls made their appearance several years ago, and have been put to very good use for special purposes.

"That leads to deflectors. Many of the new fast machines have as many as a dozen, each placed between their respective table rolls. Some are using a series of deflectors immediately after the breast roll without benefit of the usual first 5 or 6 table rolls.

"The dandy type of table roll is being used more now than heretofore. More attention is being paid by the manufacturers to having all table rolls dynamically balanced. This is a must on the faster machines. The spacing and necessary size of table rolls will probably always be a matter of opinion. Do we make them large only because of deflection, or is there some other good reason?

"The use of automatic wire tension mechanisms has become quite prevalent. Whether this is good or bad, from the papermaker's standpoint, is a question which one of our panel members asked me, but I would rather throw that one right back into their laps.

"The best method of oscillating suction boxes has created a division of opinion. We could learn things by bringing that one up.

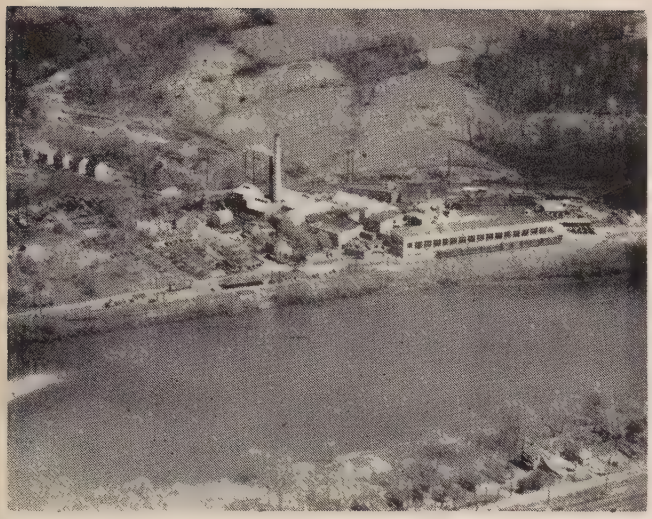
"Suction boxes are being made deeper and wider than formerly, and I am told a suction box need not weigh nearly as much as our older types. Suction box covers with their various designs is a subject which alone could last for several hours.

"The suction couch has been improved in a number of ways. Dual suction boxes have been successfully used in them, and the use of pneumatic rubber tubing for controlling the seal strip tension against the inside of the shell has now been used for some time.

"Speaking of air, we are seeing more and more of it being used in control. A recent design of a pressure inlet uses it to eliminate the need of a high head. It is used to operate wire and felt guides. The air loading of presses is quite prevalent.

"Leaving the fourdrinier proper, for a moment, we have the vacuum pickup and vacuum transfer of paper from couch to presses, which is relatively new. And on the transfer of paper, we have the Otis type of reverse second press which obviates the necessity of manual transfer over paper rolls or even the rope transfer.

"The subject of water removal from our presses, I am sure,



Mill of W. C. Hamilton & Sons, which was visited by the Delaware Valley Section

will bring out recent ideas. Is anyone curious about the new crownless press rolls?

"It would take too much time to do any further enumerating, so why don't we settle down and worm some of the answers out of the members of the finest panel I have seen together in some time?"

MR. TOURANGEAU: The members of this panel are:

B. L. Hammill, Beloit Iron Works, Beloit, Wis.
Joseph Baxter, Black-Clawson Co., Hamilton, Ohio
T. H. Latimer, Moore & White Co., Philadelphia, Pa.
P. Andrew Jackson, Pusey & Jones Corp., Wilmington, Del.
Allen A. Lowe, Sandy Hill Iron and Brass Works, Hudson Falls, N. Y.
H. C. Merritt, Downington Manufacturing Co., an original member of the panel, was unable to be present

MR. TOURANGEAU: I would like to start off tonight's discussion by calling on Mr. Lowe to give a generalization of flow systems.

MR. LOWE: In delivering stock to the wire the papermakers want ripple-less flow onto the wire at 1500 feet per minute. Every machine manufacturer is trying to solve this problem. This problem of producing ripple-less flow should be broken into three parts: (1) the headbox, (2) the pond, (3) the slice. You can have good flow from the headbox into the pond but unless the flow in the pond is correct the flow in the pond may undo everything that has been accomplished in the headbox. Likewise you can have good flow in the headbox and pond but the slice may upset this good flow if it is not designed properly. The enclosed headbox or hydraulic slice will reduce the cubic footage in the pond and gives great hope.

QUESTION: Has an attack on foam problems been made from the papermaker's point of view?

MR. JACKSON: Foam is the result of air in stock. Getting air out of the stock before the headbox is a sound approach.

QUESTION: With enclosed inlets are foam problems increased?

MR. HAMMILL: Cross entrance to the headbox can eliminate to some extent turbulence, eddies, and foaming. Good showers can help, and dirt should be completely eliminated in the headbox.

MR. LOWE: Foam can be eliminated. Flow discharges from stuff gates, screens, and flow boxes must be smooth without any cascading. Flows from one section of the machine to the other should be made below the level of the stock and the discharge openings should be as large as possible to reduce turbulence and velocities.

MR. BAXTER: Foam is nothing more than a bubble with a skin around it and the problem is one of reducing surface tension. Make sure that flanges, packing glands, etc., are tight and do not allow air to be injected into the stock.

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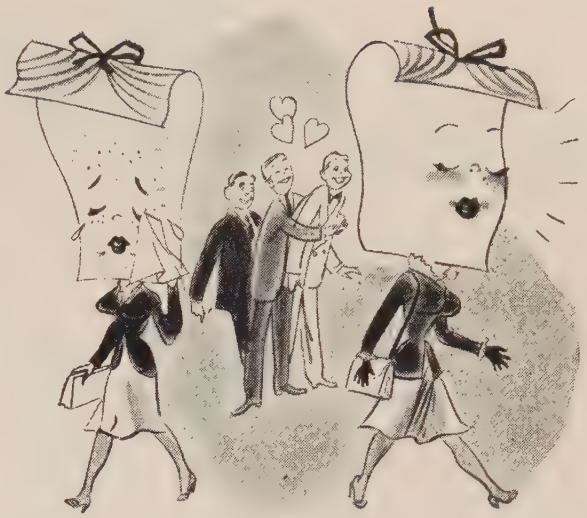

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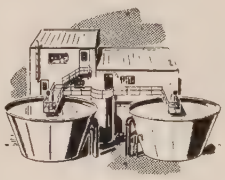

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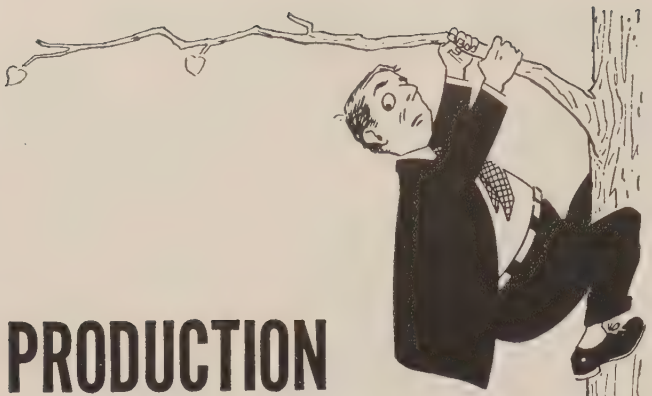

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QUESTION: How is the stock introduced at high speeds such as 2500 to 3000 feet per minute?

MR. HAMMILL: We have a machine going 2800 feet per minute but information about how we do it is restricted. After the fourdrinier it is conventional papermaking.

QUESTION: Is slice discharge level ever below the fourdrinier wire level?

MR. HAMMILL: Everyone is familiar with pressure formation and beyond that nothing can be added.

QUESTION: What effect do screens play in fourdrinier operations in regard to formation and surges?

MR. BAXTER: Pressure formation is one answer to obtaining good formation and the screen cylinder is used to hold back lumps. The round hole screen is used in the pressure type screen.

QUESTION: At what speeds are shakes unnecessary?

MR. LATIMER: 1000 feet per minute is generally accepted as the speed beyond which the action of the shake is not effective.

QUESTION: What factors are important to prolonging wire life?

MR. BAXTER: One factor is the wire slippage at the couch roll. It is also vital to hold the wire tension constant. Larger couch rolls are being used to help reduce slippage. Constant tension devices are being developed incorporating automatic sensing elements and controlling stretch rolls. The sensing devices are pneumatic with electric control on the stretch roll.

MR. JACKSON: pH has a very important effect on wire life.

MR. LOWE: Fillers will load up a wire and affect wire life. How a wire is put on is also important.

QUESTION: Which is more detrimental to wire life; weight of sheet or speed of the wire?

MR. HAMMILL: Flat box friction will determine the wear and the number of times the wire passes over these boxes will be the determining factor.

QUESTION: What experience does the panel have concerning inside and outside rolls?

MR. LATIMER: Machine manufacturers try to eliminate as many bends as possible to prevent excessive flexing, but it must be remembered that most generally wires are worn out by wear rather than flexing.

QUESTION: Are there any successful substitutes for bronze for wire weaving such as synthetic fibers?

ANSWERED FROM FLOOR: Stainless steel has been used but the resulting wire isn't as flexible as the bronze wire. Inconel has been successfully used but prices are quite high. Synthetic fibers most usually do not have the elongation characteristics necessary for good wires and will not stay properly crimped.

QUESTION: Is there more stress strain on the wire on table rolls or around large 180° wrap rolls?

MR. BAXTER: The degree of fatigue depends directly on the diameter of wrap around a roll. A certain amount of heat is generated in the first degree of flexing and no more heat is generated in bending it through 180°. If the wire is bent in one direction through 1° and then in the other direction back to a straight line more heat is generated than if the wire were initially bent through 180°.

QUESTION: Have any improvements in mechanical machine design been made to enhance the retention of filler?

MR. JACKSON: Filler has been added two-thirds down the length of the wire using a secondary headbox.

QUESTION: Has the breast roll ever been driven?

MR. JACKSON: Some paper machines have put them on and taken them off and put them on again. The problem seems to be one of synchronization.

MR. BAXTER: The future will show improvements in eliminating inertia to reduce wire wear.

QUESTION: Have magnesium or magnesium alloys been considered as metals for machine construction?

MR. BAXTER: Yes.

QUESTION: How important are oscillating suction boxes?

MR. LATIMER: Oscillating suction boxes are only important when the boxes have a tendency to groove. Grades and filler content will influence the need for oscillating suction boxes.

MR. LOWE: The oscillating box will almost completely eliminate wire freezing.

QUESTION: On lightweight sheets will variation in freeness cause a change in basis weight profile?

MR. TOURANGEAU: To my knowledge freeness does not affect basis weight profile, unless the freeness variation is sufficient to cause a change in head. Perhaps someone on the panel has some comment.

MR. BAXTER: Changes in freeness will change the flow characteristics across the machine because of the variation of orifice differences across the slice. The changes in freeness will cause changes in viscosities which because of the orifice differences will change the flow characteristics.

QUESTION: Are paper manufacturers doing anything to reduce vapors produced at the fourdrinier?

MR. BAXTER: I don't know of any, but the problem is being studied.

QUESTION: What materials should be used in suction box covers?

MR. LOWE: The Canadian industry has made an extensive study and has concluded that the suction box covers made with end of grain maple are preferable.

MR. TOURANGEAU: Thank you, gentlemen. Our time is up and we must bring this interesting discussion to a close. I want to thank the panel members for the splendid job they have done and I want them to know how much we appreciate their coming down to talk to this group.

Doctor Brill again thanked the panel members and the companies they represented for contributing so much to the success of this program. He also wished to thank the management and personnel of the W. C. Hamilton & Sons Co. for conducting the guided tour through its Miquon mill.

Pacific

Pacific Section TAPPI's first meeting of the 1951–52 season at Bellingham, Wash., Sept. 26, 1951, attracted an attendance of 125 to take part in an interesting discussion of the sulphur situation in the pulp and paper industry. With John M. McEwen, Weyerhaeuser Timber Co., Pulp Division, acting as Program Chairman, a panel of qualified members explored the sulphur problem from several angles. A digest of ideas advanced appears below.

At the conclusion of the afternoon technical meeting, members were the guests of Puget Sound Pulp & Timber Co. at a reception at the Hotel Leopold which was followed by dinner.

Professor Borje Steenberg, Director of Research in the Paper Technology Department of the Swedish Forest Products Laboratory, spoke at the evening meeting. He gave an interesting report on the physical equipment of the Stockholm laboratories and the varied types of research being done there.

E. Gray King, Puget Sound Pulp & Timber Co., Bellingham, Wash., was in charge of arrangements for the meeting. The Section Executive Committee met at luncheon to confirm program arrangements for future meetings.

Abstracts of the papers presented follow.

"Sulphur Savings at Camas" by J. V. Savage, Crown Zellerbach Corp., Camas, Wash.:

The unexpected announcement of a sulphur shortage and the subsequent delivery of sulphur on an allocation basis made it necessary for this mill to reduce sulphur usage per ton of pulp. The sulphur thus saved was needed for an increase in total pulp production to meet previously planned quotas.

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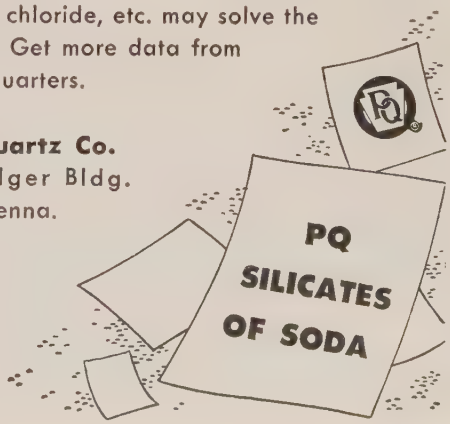

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increase in pulp production without an additional sulphur allotment.

Three definite conclusions have been reached:

1. Chip packing is the simplest and most economical method for achieving a substantial initial sulphur saving. Although packing is not the answer to the entire problem, it appears to be the best nucleus from which to start on any sulphur-saving campaign.

2. A further saving can be realized by a long pressure reduction period at the end of the cook. The addition of direct steam during the pressure reduction will add to the saving.

3. It is apparent that forced circulation from the bottom area of the digester to the top is an important factor in the production of a uniform quality pulp in a chip-packed digester.

"Pyrite Plants for Sulphite Acid" by A. Halvar Lundberg, Chemical Pulp Mill Engineer:

We are faced with the necessity of finding new sulphur sources due to the rapid depletion of our elemental sulphur deposits. This paper dealt primarily with the application of pyrites as the source of sulphur in the sulphite pulp industry.

The roasting of pyrites in the pulp industry is not new. It has been practiced in Europe for many years, and one Canadian pulp mill has operated a pyrites burning unit since January, 1932.

With the changing picture in sulphur supply there is no reason why the sulphite pulp industry of this country should not give pyrite roasting serious consideration, especially since new furnace designs eliminate most of the earlier objectionable features of the Herreshof and Wedge furnaces. The Nichols Freeman Flash Roaster and the Dorr Co. FluoSolids System can deliver burner gases of 12 to 14% SO_2, are relatively simple to operate, and the maintenance is not high.

The Nichols Freeman Flash Roaster and the Dorr FluoSolids System were described in detail, and three flow sheets were included to show how either of these furnaces could be used in the production of sulphite cooking acid.

Pyrites is an abundant material, especially from mining operations. There are some good potential sources on the West Coast which are as yet undeveloped.

The economics of pyrite burning indicate considerable savings in sulphur cost after the original investment has been made.

"Sulphur Consumption at a Bleached Sulphite Mill" by Al Graef and J. T. Firestone, Pulp Division, Weyerhaeuser Timber Co., Everett, Wash.:

Because the shortage of sulphur threatened curtailment of production of pulp, steps were taken to effect immediate sulphur savings. As a preliminary effort prior to the installation of equipment designed to effect sulphur savings, changes were made in the operation of the acid system. The liquid flows were regulated to obtain the most efficient operation possible while still not losing SO_2 to the atmosphere. The introduction of caustic soda aided these changes by increasing the absorbing capacity of the system. Several schemes were tried in the digester house and blow pits to enable more SO_2 to be returned to the acid-making system rather than be lost in the sewers.

We were able to reduce our sulphur consumption on a monthly average from 122 to 100 pounds of sulphur per air-dry ton of ships. This lower figure was the best we have been able to do so far and was done when water temperatures were less than 10°C. Summer weather brought warm water and lowered recovery efficiency.

"Semichemical-Pulping Characteristics of Pacific Coast Red Alder, Douglas-Fir, Western Red Cedar, and Western Hemlock" by J. N. McGovern, E. L. Keller, J. S. Martin, and R. M. Kingsbury, Forest Products Laboratory, Forest Service, Madison, Wis. (The paper was delivered by R. J. Seidl of the Forest Products Laboratory, Madison, Wis.):

Several Pacific Coast woods, including red alder, old and second-growth Douglas-fir, western red cedar, and western hemlock, were evaluated for semichemical pulping using the neutral sulphite and sulphate processes. The following major results were obtained:

1. The red alder, which showed characteristics typical for a hardwood in semichemical pulping, gave neutral sulphite pulps having excellent promise for use in container boards and bleached paper products.

2. The softwoods required typically high chemical and fiberizing energies in semichemical pulping by the neutral sulphite process. The pulps made from western red cedar and western hemlock had considerable promise for use in paperboard and that made from Douglas-fir somewhat less promise. Starting with the highest, the order of over-all strength properties of the pulp was: hemlock, red cedar, second-growth Douglas-fir, and old-growth Douglas-fir.

3. The sulphate semichemical pulps made from red alder and old-growth Douglas-fir had lower chemical requirements and were generally lower in bursting strength and higher in folding endurance than their neutral sulphite counterparts. The paperboards made from them were of fair quality.

4. Strong, bleached, neutral sulphite pulps can be produced in yields of 55% from red alder and 50% from second-growth Douglas-fir.

Empire State (Metropolitan District)

The first meeting of the Metropolitan District of the Empire State Section was held at Fraunces Tavern, New York City. Edward J. Mayer, Jr., President of James Gray, Inc., New York, N. Y., reported on his 43,000-mile tour of the world which was taken at the request of the Office of International Information of the U. S. Department of State.

The second meeting of the 1951–52 season of the Metropolitan District was held at Fraunces Tavern, the evening of October 9. A panel discussion on the problems of purchasing agents was arranged with J. A. Couwels, Federal Paperboard Co., Bogota, N. J., and A. V. Arenander, Jr., West Virginia Pulp & Paper Co., New York, N. Y., as guest speakers.

Mr. Couwels, confining his remarks to the problems involving paperboard, outlined the problems in fibrous materials procurement. The main material for paperboard is waste paper and since it is salvage, the classifications in supply are very broad. There is a great variation in the species and types of fibers supplied by the waste paper dealers and even by closely checking the sources, one cannot help but use a mixed furnish.

The purchasing agent is often called upon by the operators when buying market pulp, for a certain brand for certain products. There are instances when only one particular kind of pulp can be used if specifications are to be met. These preferences are very apt to vary in different mills all making the same end product but there may be some justification in that there is a variance in types of installed equipment.

With waste papers, it is not possible to control the source but Mr. Couwels indicated that more could be done to evaluate that which is supplied to the mill with the end result that the furnish can be more closely controlled.

In discussing nonfibrous raw materials, Mr. Arenander stated that quality, service, and price are the governing factors, in the order mentioned, in the selection of a certain material. The specification of quality is the responsibility of the operating department and in the selection it is important that the right quality, which does not necessarily have to be the highest, be selected on the basis of performance required for a specified end product. The service given by the supplier and the price are important but not dominant—rather, they are contributory.

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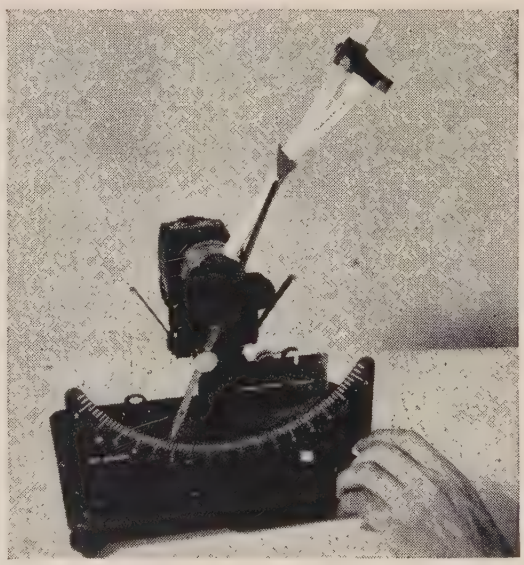

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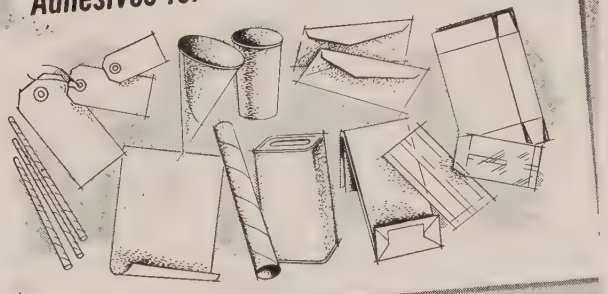

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The purchasing department is the central point in that it is its responsibility to watch all the mills, for a multimill company, time buying, and control inventory. Specifications are primarily the responsibility of the operator. Another function of the purchasing department is in the field of market research so that up-to-date information is available regarding sources of supply and new developments which might affect the purchasing plans of the company.

Mr. Arenander said that there was still the tendency to buy by brand name but this is disappearing with the introduction of product specifications. He mentioned, however, that one must be careful that the standard does not become the ceiling rather than the floor.

In conclusion, the purchasing department should be considered as the liaison between mill operation and sales.

In the discussion which followed it was stressed that the services of the technical salesmen are needed more and more. They serve to keep the purchasing department up to date as well as giving assistance to the operators. This is especially important in the introduction of newly developed raw materials. In this later regard, the paper companies expect that there be some justification in the possibilities of a new product when it is offered by a supplier since in many cases they do not have the staff or the time to investigate unknown products. This does not mean, however, that products of undetermined properties cannot be mentioned in discussion with the purchasing agent as it is possible that he may know of particular need for the material.

Empire State (Northern District)

The Northern District of the Empire State Section met at the Woodruff Hotel, Watertown, N. Y., on Oct. 11, 1951. J. Walter Couture of the Dilts Machine Works, Fulton, N. Y., gave "A Review of the European Pulp and Paper Industry."

On Oct. 25, 1951, at the Watertown High School, the Westinghouse Electric Corp. gave a spectacular demonstration of "The Influence of Research on Life Today."

Empire State (Central District)

The Central District of the Empire State Section of TAPPI met at 7 p.m. on October 5. Eighty-three were in attendance. Professor C. E. Libby presided as Chairman.

Professor Libby welcomed the TAPPI members and guests and expressed hope that there would continue to be fine turnouts at the future meetings of the newly reactivated group.

Mr. Ralph Prince welcomed the guests on behalf of the Empire State Section.

Hilliard D. Cook, program chairman, outlined plans which will enable more students from the State College of Forestry to attend our meetings. Several local mills have subscribed to a fund which will defray a large part of the students' expenses.

The principal speaker was Clifford Morse, Research Chemist, Sealright Corp., Fulton, N. Y. The subject presented was "Paper Coating in the Manufacture of Paper Food Containers and Closures."

Mr. Morse amplified the following outline referring specifically to the products made by his company:

The combination of paper and plastic to produce a superior finished product utilizing the advantages of each material to the fullest has long been recognized in our industry, and we are still investigating these combinations in the development of new products. Generally our coatings are formulated and used for a special functional value rather than for purely decorative purposes. This field is one which is constantly changing and expanding because of the continuing development of new and better plastic materials for this industry as well as through the development of better means of applying these materials to paper.

For a general discussion of the use of plastics and paper combinations we refer you to the paper given by E. C. Jahn at the TAPPI meeting at Lake Placid, entitled "Reciprocal Paper Plastics Developments" (*Tappi* 34, No. 8:8A (Aug., 1951)). In giving this paper we shall attempt to cover in a rather general way our specific requirements for finished coatings and in so doing, discuss coating methods as well as coating equipment. This will serve to give you a little more detailed picture of just how plastics and paper can be combined to produce a commercial product suitable for use in the paper food container and closure industry.

A. Physical Properties:

Shock	Flexibility
Tear	Blocking
Heat	Sunlight
Electrical	Melting or softening point
Abrasion or scuff	Adhesion
Flame (fire)	Strength
Cold	Toughness
Infrared and ultraviolet rays	Stiffness

B. Chemical:

Water	Oxidation
Water vapor	Grease or oil
Organic solvents	Gases
Acids	Other miscellaneous
Alkalies	

C. Miscellaneous

Color	Cost
Taste	Gloss
Odor	Solvent release
Toxicity	Feel
	Aging

D. Other Miscellaneous Questions to Be Considered:

Application equipment needed	Stability on storage
Other manufacturing equipment needed	Ease of handling
	Technical control needed

The various coating methods which we feel can be used for film disposition commercially are as follows:

A. Organic solvent solutions (cold solutions—hot solutions)
B. Organic solvent dispersions such as organosol and plastisol
C. Water dispersion such as latex or emulsion
D. Hot melt such as extrusion

If you will refer to the very excellent TAPPI Monograph No. 8, entitled "Machinery for Paper Coating," you will see that there are 10 basic designs for coaters and I will take the liberty of adding an 11th group as follows:

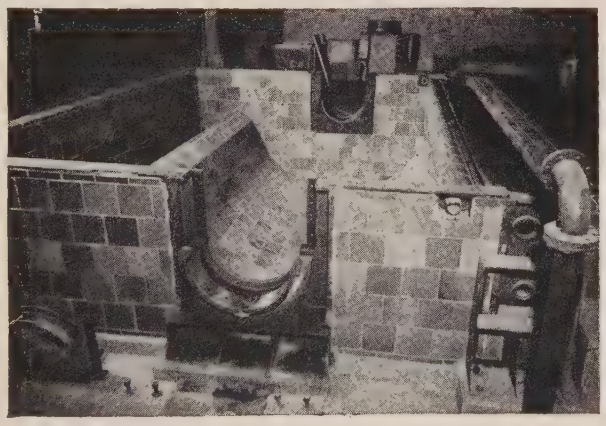
1. Dip
2. Knife
3. Cast
4. Roll
5. Brush
6. Air
7. Spray
8. Print
9. Extrude
10. Strip
11. Other specialty equipment

Because these coaters are covered in quite some detail in the Monograph, we shall not try to explain in any detail these coating machines, but I shall narrow the group down to those which we use now or foresee a possible future use for in our process.

We would narrow these 10 basic designs down to the following groups which we feel are of interset to us:

A. Roll—reverse roll
B. Air knife
C. Print
   (1) Letter press
   (2) Rotogravure
   (3) Offset rotogravure
D. Extrude
E. Miscellaneous specialty coaters

In concluding this rather general discussion of our specialized use of plastic paper combinations, we would like to point out that the field is still wide open. There are a great many developments to come in the future in this particular business



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depending mostly on the strides made by the chemical and plastics industry in producing resins, etc., which will meet our specifications and our requirements. The progress of the chemical and plastics industry in producing improved materials for this use will also depend on further developments in the paper coating equipment field. Inasmuch as this is a comparatively new business the future is still ahead.

The next meeting was held at 7 p.m. at the University Club, Syracuse, on Friday evening, November 2. Earl Foster, Chief Chemist for the Sealright Corp., Fulton, N. Y., presented a paper entitled "Quality Control in Paper Food Container Manufacture."

Lake Erie

The new Lake Erie Section has announced the following schedule of meetings for 1951–52:

Oct. 19, 1951:	"Why Convertors Aren't Satisfied"
Nov. 16, 1951:	"Does a Training Program Pay"
Dec. 21, 1951:	Christmas Party
Jan. 18, 1952:	"Tomorrow's Industrial Protection Packaging"
Feb. 15, 1952:	"Cashing in on Suggestion Systems"
Mar. 21, 1952:	"Graphic Arts"
Apr. 18, 1952:	"Practical Process Controls for Better Quality"
May 22–23, 1952:	Folding Carton Conference
July 18, 1952:	Summer Outing

New England

The New England Section of TAPPI held its first meeting of the 1951–52 season on October 5 at the Berkshire Inn, Great Barrington, Mass. During the afternoon visits were made at the Byron Weston Co., Crane & Co., Inc., and Rising Paper Co.

At 6 p.m. the E. D. Jones & Sons, Inc., were hosts to the TAPPI group at a cocktail party at the Berkshire Inn. A hundred members were in attendance at the banquet which was followed by a discussion of "Effect of Drying on Dimensional Stability of Paper" by Geoffrey Broughton, head, Department of Pulp and Paper Chemistry, Lowell Textile Institute, Lowell, Mass.

Program Committee for this meeting were Messrs. Knudson, Benson, and Dreis. F. S. Klein was in charge of local arrangements.

The next meeting will be held at the Roger Smith Hotel, Holyoke, Mass., on November 16. The general theme will be "Economics of Paper Machine White Water Utilization." Program Committee will consist of Miss Kiely and Mr. Dries with Miss Kiely in charge of local arrangements.

Ohio

The Ohio Section of TAPPI started its 16th year with a record attendance of 183 persons present at the dinner meeting Monday, October 8, in the Manchester Hotel, Middletown, Ohio. This was a new attendance record for a regular meeting, excluding joint meetings held with other organizations. Ohio Section Chairman Herb Smith of Mead Corp., Chillicothe, Ohio. presided. The National TAPPI President and Vice-President Ken Geohegan and George Pringle, respectively, both being members of the Ohio Section, were among those present at this meeting.

President Geohegan presented greetings from the National organization. He also expressed his thanks and appreciation for the gift the Ohio Section presented him, last Spring, honoring his election to the National TAPPI presidency.

Mel Lyons and Don Jenkins of The Champion Fiber and Paper Co., Hamilton, Ohio, were presented as the new editors of *The Ohio TAPPI News Letter*. This is to be a monthly publication pertaining to the activities of the Ohio Section.

The speaker of the evening was Borje Steenberg of the Swedish Royal Institute of Technology, Stockholm, Sweden. Dr. Steenberg presented a slide-illustrated lecture on the subject "The Effect of Some Paper Machine Variables on the Properties of Paper." His remarks are summarized as follows:

The effects of paper machine operation and the different characteristics of the paper produced from the same furnish on two different machines have been major problems in the industry. However, techniques for studying the paper ma-

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chine operation have not been too well developed. Using the techniques of stress-strain measurement, the paper machine operation can now be studied. Dr. Steenberg's lecture was, in general, confined to the effect of tension and internal stresses.

Fiber orientation has an effect upon the directional strength of machine-made paper. However, from the experiments discussed of wetting and subsequent drying of the sheets under tension, it has been demonstrated that the directional strength of the sheet can be reversed, although the fiber orientation was not disturbed. Samples obtained from the machine at various points, from after the couch roll through to the dry end of the machine, indicated the directional effect was developed in the sheet as it progressed through the machine. The samples obtained immediately following the couch roll exhibited very little directional effect. Theoretical and mathematical analysis indicated that the stretching of the sheet through the various draws of the machine could not change the orientation of the sheet fibers in a great enough magnitude to account for the directional strength developments. The internal stresses developed at the fiber-to-fiber bond offer a logical explanation. These stresses are introduced by stretching the sheet at the various draws through the paper machine, plus its tendency to shrink on drying.

To study the stress-strain properties of paper it was necessary to develop suitable testing equipment. The pendulum type equipment in common use in the United States for tensile measurements is not capable of being adapted to this type of study. The equipment developed is an electronic-controlled instrument which permits constant rates of loading and elongation to be maintained.

From the studies made it was shown that paper exhibits rheological properties somewhat resembling other structural materials. The rheological approach pays particular attention to the prerupture stress-strain characteristics, instead of concentration merely upon rupture strength, and it emphasizes the importance of the time factor, both in testing and usage of the materials. By studying the stress-relaxation effect of paper under constant deformation it is possible to establish and determine the effects of the draws in the paper machine, and the stresses they impart into the sheet. The practical strength of paper is as much determined by its ability to stretch as by its ability to take the load.

From analysis of the stresses, logical explanations of the edge effect of machine-made paper can be made. The dimensional stability of paper can be analyzed and machine operating conditions outlined to produce the desired effects. Glassine paper, where transparency is affected by stretching, is an example of where knowledge of the stress-strain relationship can be of great value.

In the discussion period following Dr. Steenberg's lecture it was clearly brought out, the value of stress-strain information on paper. Several questions were asked regarding machine operating conditions to produce certain desired characteristics which Dr. Steenberg had not previously been acquainted with. However, from the explanation he presented, based on the effect of tension in the sheet, he was able to predict machine operating conditions which confirmed those found from experience in our mills here.

K. P. Geohegan, Howard Paper Mills; Borge Steenberg, Swedish Forest Products Research Laboratory; and H. A. Smith, Mead Corp.

In conclusion Dr. Steenberg urged more attention be given to experimentation on the paper machine. He emphasized that the machine-lost production due to an experimental program was usually only a small fraction of the total project cost.

Program Chairman John Clouse announced the next meeting of the Ohio Section would be held November 8 at the Hartwell Club House, Cincinnati, Ohio. W. C. Bloomquist of the General Electric Co. will discuss gas turbines.

Southeastern Pulp and Paper Society

The second meeting of the Southeastern Pulp and Paper Society was held at the King and Prince Hotel, St. Simons Island, Brunswick, Ga., on Sept. 14–15, 1951. About 110 were present.

Glenn C. Kimble of the Union Bag & Paper Corp., Savannah, Ga., opened the meeting and introduced G. K. Singletary, of Brunswick Pulp and Paper Co., Brunswick, Ga.

MR. SINGLETARY: I want to welcome you to the second official meeting of Southeastern Pulp and Paper Society. The Brunswick Pulp and Paper Co. will continue to support this organization as long as it continues on a businesslike basis. Any organization of this kind can only go on if the mills in the area give it their support. I honestly feel that you will give it that support, and therefore I feel that it will be

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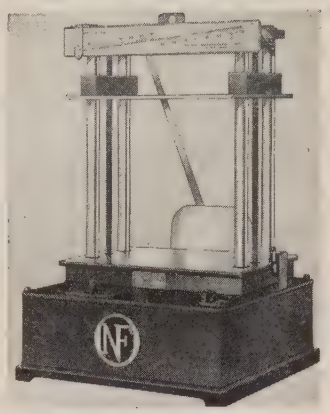

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successful. We, at Brunswick Pulp and Paper Co., feel that an organization of this kind is a good thing as a means of developing young men. We all recognize that as one of our jobs today.

I hope some of you plan to spend the week end on St. Simons Island and in Brunswick, and if so, Mr. Widener has planned a golf tournament on the Sea Island Course or at the Brunswick Country Club. Tomorrow morning you will be taken on a tour of the Brunswick Pulp and Paper Co. plant. We hope that during your stay in Brunswick you will call on us for anything we can do to make your stay a pleasant one.

MR. KIMBLE: We appreciate your courtesy and the offer to visit your plant tomorrow. We have a technical program coming, but first we have some business. We have with us J. R. Lientz, who is a member of the TAPPI Executive Committee and he has been asked to help us. We will have to do some voting on officers of the organization and would like to ask that Mr. Lientz take the chair for this part of the business meeting.

J. R. LIENTZ (Union Bag & Paper Corp.): It is certainly a pleasure as a representative of TAPPI to be present at the organization of what we hope will be a great society. It is nice to participate in the beginning of an organization such as this. Since a part of organization work is to set up some standards by which to operate, we tonight want to discuss and vote on some articles of organization. Last Spring Articles of Organization were set up and circulated to this group. If there are any questions or changes to be made regarding the constitution under which to operate we would like to hear them at this time.

M. B. PINEO (Brunswick Pulp & Paper Co.): Article II, Section 2, has a provision saying that only members of Southeastern Section of TAPPI can vote or hold office. It seems that this article is a bit premature in that this group is merely a society. I think that this particular article should be stricken so that anybody, whether members of TAPPI or not, can participate.

G. K. Singletary, Brunswick Pulp & Paper Co.

MR. WATERS (Southern Pulp & Paper Manufacturers): On a point like that, the Nominating Committee should be sure that those nominated are members of TAPPI. Be sure that at the time you begin your charter the officers are members of TAPPI.

MR. LIENTZ: It seems to be the general consensus, that Mr. Pineo's suggestion be accepted. If there are no further questions, I would like to ask that all in favor of accepting the above exception please raise their hand.

Voting followed and the majority voted in favor of striking Article II, Section 2, from the Articles of Organization.

Voting was held to accept the Articles of Organization. It was unanimously voted to accept them.

MR. LIENTZ: We must carry through an election of officers for the coming year, who, according to the constitution, will serve for this year and through the meeting in May. At the last meeting the Nominating Committee was appointed and took action and at the request of the Committee, the Secretary forwarded the nominations of 2 or 3 men for each of the 3 offices. The nominations shall be announced to the members of the Society at least 30 days in advance of voting. I would like to appoint as tellers for the election Mrs. Barbara McIntyre and Miss Sarah Hammons. Following the program results the will be announced.

Election of officers by secret ballot was held, with the following results:

Chairman—G. C. Kimble, Union Bag & Paper Co., Savannah, Ga.
Vice-Chairman—W. M. Ebersole, Macon Kraft Corp., Macon, Ga.
Secretary-Treasurer—J. E. Scofield, Rayonier, Inc., Fernandina, Fla.

The business meeting over, the technical part of the meeting began. Wilson F. Brown, University of Florida, read a paper entitled "Further Discussion of a New Continuous Process for Kraft Pulp."

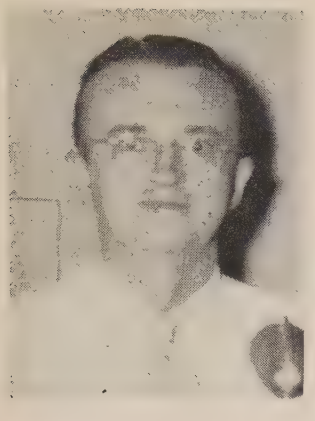
Furthur Discussion of a New Continuous Process for Kraft Pulp

Wilson F. Brown

THERE has been developed at the pulp and paper laboratory at the University of Florida a continuous pulping process in which wood chips can be converted into chemical pulps in 25 minutes or less as contrasted with the usual 3 to 4 hours of the normal batch type procedure. The chemical pulp strengths as shown by physical tests are equal or better than pulps prepared by the standard batch method. The method was developed about a year ago by W. J. Nolan of the Laboratory staff. A great deal of data and information have been compiled during the year that show the process has good commercial possibilities. A patent has been applied for by the University through the Research Corporation who are handling the details.

The process was developed on the principle that the reaction is a surface reaction between the wood and the pulping chemicals instead of being a strictly penetration phenomenon. Therefore, on the basis of this principle, the greater the specific surface of wood that can be exposed to the cooking

WILSON F. BROWN, University of Florida, Gainesville, Fla.



G. C. Kimble, Union Bag & Paper Corp.; Chairman, Southeastern Pulp & Paper Society

W. M. Ebersole, Macon Kraft Corp.; Vice-Chairman, Southeastern Pulp & Paper Society

chemicals the faster and more uniform should be the reaction.

When increased temperature and concentration are used in a regular batch cook on a normal size chip the outside of the chip is greatly overcooked before the inside is attacked. This is especially true when the concentration is maintained constant. If the time of cooking is shortened to prevent overcooking the outside of the chip then a hard core remains which is more or less uncooked. Conversely, if the time of cooking is lengthened to the point where the center of the chip is cooked, then a loss of cellulose results. In the continuous process, however, the use of greater surface area per unit weight of wood permits use of increased temperature and concentration of liquor with consequent rapid removal of noncellulosic materials with a minimum degradation of cellulose.

The process may be divided into three parts as follows:

1. Softening of Mill-Size Chips. Chips are subjected to steam pressures of 150 to 170 p.s.i.g. for periods of 5 to 10 minutes in order to soften the lignin. Only sufficient chemical, such as sodium carbonate, is added to prevent acid hydrolysis during the steaming process.

2. Increase of Surface Area of Chip. The expansion of surface area beyond that of normal wood chips must be done in such a manner that the fiber length will not be reduced. The use of standard attrition mills for this purpose is not satisfactory as the action of the mill tears a high percentage of fibers. The best method of size reduction consists of splitting the chips along the grain producing a large number of thin sticks very small in cross section but each as long as the original grain direction of the original chip. This is done by subjecting the softened chips to the action of a modified swing hammer mill or other mechanical equipment to accomplish the same purpose. This results in a large increase in surface area with very little breaking of fibers. The discharge screen in the mill must be of proper size as small screen openings cause retention of material in the mill with consequent damage to the wood fibers.

3. Pulping of Shredded Wood. Shredded wood is mixed with the cooking chemicals at cooking temperature. The cooking temperatures are in the range of 350 to 375°F. and are kept constant. The cooking liquors are made up of a mixture of sodium hydroxide and sodium sulphide at concentrations between 20 and 80 grams per liter. Concentration is maintained substantially constant during the cook. Time of pulping is 15 minutes or less.

Pulps of varying characteristics may be obtained by changing the temperature, concentration time, and specific wood surface. Under certain conditions dissolving grades of high alpha pulp have been produced from scrub oak in 15 minutes' pulping time with the following properties:

Yield of pulp	45%
Alpha-cellulose	92–95% (unbleached)
Lignin	1–2% (unbleached)
Pentosans	3–6% (unbleached)

These pulps have a permanganate number comparable to the best grades of sulphite dissolving pulp.

Papermaking pulps, high in pentosans, with yields of 55 to 60% may be obtained by adjustment of the pulping variables. High yield semichemical pulps using neutral sodium sulphite have been produced in extremely short retention time.

The yield obtained by the continuous process is in the neighborhood of 10 to 15% higher from the same weight of wood when compared to yields obtained by the standard batch cook on normal size chips. The increased yield is due apparently to the fact that there is very little degradation of the cellulose and practically all of it is recovered as alpha-cellulose.

The quality of the pulp produced is uniform as would be expected. The control of the reaction is simple and conditions can be varied at will. Both quality and control should be much better than can be obtained in existing batch processes.

There should be less steam consumption in the continuous process because relief blow is eliminated as well as the cooling and reheating of the digester. In addition better heat recovery should be effected as the blowing will be continuous and at a relatively low rate. Consequently a small heat exchanger should be enough and it will operate at peak efficiency. The actual amount of steam consumption will be determined when the pilot plant is ready to run.

A pilot plant will be installed at the laboratory to test the process on a semicommercial scale. The pilot plant is being designed on the basis of 6 tons of pulp per day so that it will be large enough to get actual data for large size installations. Standard equipment is being used and is being contributed or loaned by interested companies. It is hoped to have the

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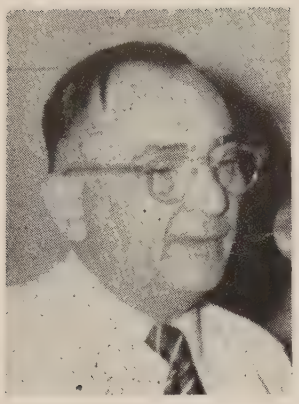

W. F. Brown, University of Florida

George Seymour, Brunswick Pulp & Paper Co.

equipment assembled and installed shortly after the first of next year.

Consideration has been given to possible effects on the remainder of the pulping plant including the recovery system. The causticizing equipment would have to be larger than when the batch system of cooking is used because there will be more soda carried in the system. The black liquor would be returned to the recovery system at almost the full strength of active alkali due to the injection of concentrated chemicals at the cooker in order to maintain constant concentration. The additional causticizing capacity needed would be due to that increase of active alkali.

It is believed that the washing of the pulp from the continuous process would not require appreciably more wash water than the pulp from batch cooks because of the countercurrent system of washing used. It is possible that one additional stage of washing might be needed. Problems of this sort are expected to be answered when the pilot plant is in operation.

The process described has been worked out completely in the laboratory with the exception of a few very minor points which are now under investigation. It is believed that the trials on the large pilot plant basis which will take about a year to complete will show that the process is commercially feasible. The flexibility, the accurate control, the higher yield, and the economy of the process should establish it as a major contribution in the field of pulp and paper.

Discussion

MR. RICHTER: I don't understand the reason for making changes in the caustic room. You are only going to use a definite amount of caustic per ton of pulp. Why would it throw an extra load that would necessitate any changes in your caustic room?

MR. BROWN: We are replacing any caustic used by injection.

MR. RICHTER: Six hundred pounds per ton would be a constant amount consumed regardless of whether you came out with the same concentration you started with initially. If you are consuming 600 pounds that is all you would have to make up in your caustic room.

MR. BROWN: We have done this in the laboratory and have speculated what will happen. We believe it will be increased probably 50%.

MR. WHITESIDE: In doing this, have you done any cooks on a basis of the same concentration all the way through?

MR. BROWN: Yes. We made a great many on a normal cook procedure.

MR. WHITESIDE: Would it have disadvantages?

MR. BROWN: It takes too long. Instead of consuming 2 to 5 hours on a normal cook, depending on end product, we were able to do it in 15 minutes.

MR. BORLEW: Why would you qualify this as a continuous operation?

MR. BROWN: We expect to steam and go into a hammer mill and go directly into a cook, but not with the same equipment.

MR. SCOFIELD: Does the operation produce changes in size? Is this just a reduction in size, or does it have certain other characteristics that enhance the penetration?

MR. BROWN: One company is shaving their chips. Their cooking time is still 2 hours.

MR. SCOFIELD: If you cook these up to the same size would it do the same thing?

MR. BROWN: As far as I know.

MR. SCOFIELD: When you reduce them to matchstick size do you crush them?

MR. BROWN: I don't think so.

MR. WHITESIDE: In this reduction of chip size by means of crushing, are you screening the chips before, or doing anything to get rid of debris?

MR. BROWN: Yes. They are already screened.

MR. WHITESIDE: After the chips are received and are crushed, is there any debris involved? Is there any loss in crushing?

MR. BROWN: If so it is so small we have not been able to find it. Due to the fast cooking it doesn't seem to be large enough to matter. If it goes too fast, you have no control over it.

Louis Wirth, Jr., National Aluminate Corp., read a paper, "Hot Lime-Zeolite—a Versatile Water Treatment Process."

Hot Lime-Zeolite—A Versatile Water Treatment Process

Louis Wirth, Jr.

"SIMPLICITY of design and operation at a low installation and operating cost" has long been the desire of operators of water treating plants supplying high percentages of makeup to high-pressure boilers.

With the development of the hot lime-zeolite method of water treatment, a close approach to these demands is now possible. By coupling together the desirable functions of the hot process softener with those of the zeolite softener, it is possible to obtain a feedwater that is free of hardness and low in alkalinity and silica.

Ion exchange processes have been used at low temperatures to produce water of very low hardness residual and having other desirable characteristics. These processes include regular zeolite softening on the sodium cycle, split stream (sodium hydrogen blending method) for alkalinity, dissolved solids and hardness reduction, and deionizing for complete removal of all electrolyte and silica. The initial cost and complicity of such equipment, as well as the operating cost, increase with the more desirable characteristics of the water produced.

Precipitation procedures, both hot and cold, provide the most economical means of carbonate hardness removal. Clarification is gained in the treatment of turbid supplies by incorporating with the lime treatment, coagulants which react to form flocculent precipitate. Soda ash, or in select cases, caustic soda, precipitates noncarbonate hardness with the resulting residual total hardness influenced to a degree by the excesses of sodium alkalinity maintained. This precipitation process is especially effective at elevated temperatures, as lower hardness residuals are obtained with lower excess alkalinities. By supplementing the cold lime or lime-soda softener with zeolite, hardness residual has been reduced to a minimum. Operation of this kind has been carried out since the early "twenties" with greensand zeolite first being employed. The necessity for careful control of pH value through these materials often required the prefeeding of acid. Higher capacity and more stable zeolites were subsequently developed with current operations of this nature using synthetic resinous materials of the styrene base type. Complete resistance to conditions which caused the degradation of the siliceous zeolite and formaldehyde resins has made the styrene resin a most useful material.

Up to now, the hot process phosphate softener has been the only means of completely softening the effluent of a hot lime-soda softener external of the boiler. This method of treatment has served in the supplying of large quantities of low hardness water for boilers in the pressure range of 400 to 1250 p.s.i.g. and higher. The primary objections to this treating system

LOUIS WIRTH, JR., National Aluminate Corp., Chicago, Ill.

have been the slippage of magnesium through the primary treating unit and into the phosphate softener and in some cases difficulty with turbidity from the phosphate softener. Magnesium phosphate sludges accumulate in the preboiler and boiler system with tube failures often the result. Because of the high cost of phosphates, hardness reduction is pushed to low levels in the lime soda unit. This leaves excesses of carbonate alkalinity in the secondary phosphate treated supply to the boiler.

The development of styrene-type base exchange products has extended the field of ion exchange application to the treatment of water at temperatures as high as 250°F. with at least one installation being made presently at 285 to 290°F. Resins have been exposed to such temperatures since 1947 under actual operating conditions with no degradation taking place.

The hot lime-zeolite process takes its name from the "marriage" of the hot lime-soda softener and the zeolite softener. Soda ash as well as phosphate have been dropped as external treating chemicals, their work being done by the ion exchange unit with no undesirable alkalinity excesses or after precipitation resulting. By careful consideration of treating reagents, it is possible to accomplish the following:

1. Hardness reduction to "zero."
2. Alkalinity reduction to as low as 15 p.p.m. without the use of acids.
3. Silica reduction to tolerable limits of most steam generating and turbine systems.
4. Dissolved solids reduction equal to the total alkalinity less approximately 30 p.p.m.
5. Clarification to "zero" turbidity.

These accomplishments are made possible through the use of chemicals such as:

Primary Hot Process:

1. Lime (temporary hardness reduction).
2. Sodium aluminate (clarification).
3. Magnesium oxide (silica removal).

Secondary Hot Zeolite:

1. Sodium chloride (salt) (complete hardness removal).

In applying the hot lime-zeolite process to various water supplies, its versatility is a marked achievement over that of other processes or combinations of such. In Table I are listed some waters of widely varied characteristics which are being or will soon be treated by this process.

In treating water A, emphasis is placed on clarification, silica and iron removal in the primary hot lime softener. Sodium aluminate serves to coagulate the suspended solids which vary greatly with seasonal changes. The primary treated effluent is left with a very low alkalinity, as only sufficient lime and sodium aluminate are used to precipitate the magnesium, keeping excesses at a minimum. Optimum silica removal is effected at pH 10.1 to 10.2. The hardness of the primary treated effluent will not be reduced, this consideration being left entirely for the secondary hot zeolite units.

In treating water B, primary emphasis is placed on silica removal in the hot process unit. As magnesium is low in the untreated supply, magnesium oxide will be required to supplement that which is present. Caustic soda would normally be used to supply the necessary alkalinity. Some hardness reduction is effected at the expense of excess alkalinity. When no particular regard to hardness reduction in the primary softener is necessary, the alkalinity of this low dissolved solid water can be kept at a minimum by using lime instead of caustic soda to supply the hydrate necessary for optimum silica removal. The primary treated supply is then filtered and treated for hardness removal by hot zeolite.

Waters C and G contain appreciable noncarbonate hardness. This type of water when treated with lime only or with lime, sodium aluminate, and/or magnesium oxide in the hot process softener, is maintained at a low level of alkalinity as the unit is operated as an excess calcium softener instead of an excess soda softener. Hot zeolite treatment effectively removes the residual hardness to extremely low levels.

Water D is similar to C excepting that a higher alkalinity will result due to the small quantity of noncarbonate hardness. Water E requires that extreme emphasis be placed on silica removal. Every consideration can be given to the maintenance of magnesium excesses and alkalinity conditions pertinent to good silica removal with hardness removal left primarily to the hot zeolite units.

Table I

	A	*B*	*C*	*D*	*E*	*F*	*G*
Hardness as $CaCO_3$	128	27	247	163	200	167	405
Ca as $CaCO_3$	87	18	152	139	100	110	258
Mg as $CaCO_3$	41	9	95	24	100	57	147
"P" as $CaCO_3$	0	0	0	0	0	0	0
"M" as $CaCO_3$	1	12	157	154	121	139	296
Cl and SO_4 as $CaCO_3$	171	25	81	27	104	41	132
Fe as Fe	12	...	...	2	5	...	...
SiO_2 as SiO_2	5	10	26	22	58	3	15
pH value	4.4	...	...	...	7.5	8.3	...

A, Typical Ohio River water. B, Georgia surface supply. C, Florida water. D, Florida water. E, Georgia water. F, Lake water, Northern Michigan. G, Michigan well water.

In the treatment of water of high silica content such as listed under B, C, D, and E, excesses of magnesium present in the primary hot process softener often result in magnesium leakage from this unit. If a secondary phosphate softener is in use following this condition, magnesium phosphate is formed which is adherent and damaging to the boiler, in many cases causing tube failures when the boiler is carried at high ratings. A study of the hardness residuals existing periodically in the effluent of hot zeolite softeners reveals that when leakage of hardness does exist, calcium only will be present, the magnesium being held at a minimum. This condition exists when hardness leakage results from accumulation of suspended matter requiring backwashing to again produce zero hard water.

Water F in Table I is being successfully treated by the hot lime-zeolite method. A thorough evaluation of this system during the first 9 months of operation was reported at the annual meeting of the ASME, December, 1950 (*1*). A recent review of conditions after 20 months' operation has established that the operating cost of this process (chemicals only) is 30% less than that of the previously operated hot lime-soda phosphate unit. This unit has been operating in the supply of make-up to 450 p.s.i.g. boilers. Internal inspection of these steam generators shows them to be in excellent condition with no sludge accumulation or scale. Previous inspections while operating with the hot lime-soda phosphate unit showed areas of heavy sludge accumulation, especially in the top drum, and it was necessary to clean the boiler after each 6-month period of operation. The primary hot lime-aluminate softener is currently being controlled by a pH recorder and controller. This is made possible by the elimination of soda ash as a treatment chemical, sodium aluminate being fed with the lime.

Table II

Ca as $CaCO_3$	*CO_3 as $CaCO_3$*
30–40	25–30
40–60	20–30
60–80	15–20

In the foregoing, low alkalinity of the treated supply has been emphasized as an advantage gained through the elimination of soda ash. This is especially important when treating waters of low dissolved solids content where alkalinity may be the factor controlling boiler blowdown. A study of alkalinity

conditions possible when operating the hot process unit as an excess calcium softener is shown in Table II.

These conditions were evidenced in a sludge blanket type softener operating with lime and sodium aluminate only as treatment chemicals.

The styrene base exchange resin used in the hot zeolite operation is a very rugged material. There has been no evidence of deterioration either in the laboratory or in plant operations (*2*). It was early felt that material of this sort might break down should it be exposed to the thermal differences which are sometimes existent in standard hot process operation. This degrading effect has never been noticed, and laboratory testing in which the resin was exposed to very severe thermal shock produced no fracturing of resin particles. The major problem which might occur through an operating mishap is the possible dehydration of the resin bed. Such a drying-out results in a shrinking of the beads of resin which if rewetted too rapidly fracture. By controlling rehydration through use of a 10% brine solution, no fracturing is evidenced.

Ion exchange softeners designed for hot or cold operation should have adequate resin bed depths. A 30-inch bed is recommended as a minimum. Some installations are running and being installed with depths of 24 inches and less. Bed depth of less than 24 inches should not be used for production of boiler feedwater for high-pressure steam generators. Hardness leakage due to channeling and a lowered regenerant efficiency result from the use of shallow beds. Adequate salt dosage should be designed for also. There is a tendency toward overemphasizing salt economies possible with styrene-base cation exchange resins. For boiler feedwater treatment, prime consideration should be placed on water quality. Styrene resins such as Nalcite HCR should not be operated at less than a 6-pound salt dosage with provision in design allowing for a 10-pound salt dosage per cubic foot of resin.

There is a growing tendency to apply hot lime-zeolite treatment where demineralizing would have previously been considered necessary. If the steam generating unit is of such design as to allow for operation with relatively high dissolved solids boiler water, many factors governing plant operation are in favor of hot lime-zeolite. These are briefly summed as follows:

1. Lower installation cost.
2. Lower chemical operating cost.
3. Lower maintenance and operating labor cost.
4. The treated supply is noncorrosive and nonscaling, and will not pick up iron from preboiler system.
5. After-treatment chemicals like phosphate and organic dispersives may be fed to the boiler feed pump suction.

Hot zeolite softeners may be used in the treatment of contaminated condensate supplies. In addition, should an outage of the primary hot process softener occur, cold water may be passed directly through these units for hardness removal only.

LITERATURE CITED

1. Wirth and Butler, ASME paper No. 50-A-77, Power Plant Operation with Hot Lime Zeolite.
2. Lindsay, Wirth, and Durinski, Ion Exchange in High Temperature Industrial Applications, *Ind. Eng. Chem.* (May, 1951).

Discussion

MR. TUCKER: I notice you state there is no thermal shock, but do you recommend that hot or cold water be used? Is there no thermal shock by using cold water?

MR. WIRTH: It is obvious that with backwashing it could be carried out with the hot process water. The major problem is the consideration of corrosion when using cold brine. Brines are, in particular, corrosive due to the steel if there is no oxygen present. If you did apply cold brine, it would be about 6 inches above the bed, depending upon the size of the diameter. Temperature recorder would show slow change. Tests we conducted were made under a microscope by pushing resident parts under filter and immediately setting into cold water, reducing the temperature, and observing under the microscope.

MR. SCOFIELD: What about hardness reduction to zero?

MR. WIRTH: We did not obtain zero hardness.

MR. WHITESIDE: In lime soda softener of calcium carbonate, will you lose capacity to a certain extent, or would you lift your capacity on back water?

MR. WIRTH: I believe you can operate on treated water longer than you can a filter.

George Seymour, Brunswick Pulp and Paper Co., read a paper on "A Method of Inventorying Straw-Piled Wood."

Method of Inventorying Straw-Piled Wood

George Seymour

THE main reason for taking inventory of the wood on hand is for cost accounting purposes. Since accountants always carry figures out to dollars and cents the inventory must be as accurate as possible. Our wood is bought on a basis of weight units, of which one unit is 7100 pounds pine (7200 pounds gum). The inventory of the wood must be made on a volume basis, therefore, an accurate factor must be determined for the volume occupied by one unit of wood when stacked in the manner customary to each individual user. This factor will vary depending on the relative amounts of straw-piled wood to ricked wood in a pile, the length and diameter of each log, and other factors which are not large enough to be considered here.

Measuring the wood in a ricked pile is quite simple and the volume which one unit of wood occupies is 168 cubic feet. When wood is straw piled there are more void spaces and the factor is always larger than 168. Here at Brunswick Pulp & Paper Co., we use a factor of 232.8 cubic feet per unit of wood which has worked out quite well for our piles. It is not recommended that this factor be used for wood at other mills. To determine the factor to be used several piles in which the unit content is known should be measured as accurately as possible and the volume determined in cubic feet. Then the factor is found by dividing these volumes by the number of units in each pile. This factor can then be used regardless of the method used to determine the volume of the pile.

This brings us to the methods of measuring the piles to determine the volume. Since 1944 all wood stored by Brunswick Pulp & Paper Co. has been straw piled with ricks around the pile. The size of our piles will normally be in the range between 800 and 2500 units.

The first method of inventory used here was by laying out a rectangular base line around the pile with a transit and steel tapes. In our wood yard the railroad tracks are straight along one side of each of the piles and are used as a permanent base line from which the rest of the rectangle is laid out. The right angle from the tracks is easily made by using the sextant set at 90° or with tapes forming a 30 by 40 by 50-foot triangle with one of the short sides along the tracks. A marker is then set up, the two 100-foot tapes tied together and stretched over it and out 150 feet where a corner marker is placed. The other corner of the base rectangle is located in the same manner and stations are marked off at 20-foot intervals. The base lines for our larger piles form a rectangle 150 feet wide and 260 feet long. This gives us 12 stations 20 feet apart for cross-sectional area measurements and the distance from the first and last stations to their respective ends of the pile plus the distance between the first and last station gives the total length of the pile.

The cross-sectional area at each station was measured by plotting the following data: (1) distance to pile from station measured with tape, (2) rick height measured with tape, (3

GEORGE SEYMOUR, Brunswick Pulp and Paper Co., Brunswick, Ga.

J. R. Lientz, Union Bag & Paper Corp.

M. B. Pineo, Brunswick Pulp & Paper Co.

vertical height of transit, (4) angle from transit to top of pile, and (5) distance from transit to top of pile. The last three readings are taken only on one side of the pile, which locates the peak, thus eliminating the transit set up on both sides. These data were plotted on graph paper and the area determined by counting the squares. The volume of the pile was then determined by multiplying the average cross-sectional area by the total length of the pile. Dividing this volume by the factor cubic feet per unit of wood gives the units in the pile.

This method is fairly accurate but quite cumbersome since the transit must be set up at each station on one side of the pile and it was necessary for one man to walk the top of the pile to get the stadia readings.

The second method used was to lay out the base lines with the transit and tapes and measure the pile with tapes. One man walked the top of the pile holding the ends of two 100-foot tapes. One tape going down each side of the pile to get the rick heights, distance from base lines, and distance to the top of the pile from both sides. This required 5 men but was faster than setting up the transit at each station on one side of the pile. The cross-sectional area was then calculated using the S formula for the top triangle, base $\times$ height/2 for the second triangle and base $\times$ height for the rectangle.

$$(S \text{ formula}) \text{ area} = S\sqrt{(S - A)(S - B)(S - C)}$$

where $S = {}^1/_2(a + b + c)$.

The total volume and units were calculated the same as before i.e., average area $\times$ length divided by the factor to get the total units. There are several errors in this method of measurement, one is that the wood is assumed to be piled in the form of a triangle from the outside of the ricks to the top of the pile. This is very seldom true and in some cases the wood is in the form of a cone where the bottom of the rick is the part joining the straw-piled wood.

This method like the first is accurate enough on regular piles, but requires 5 men with one of them on top of the pile. The calculations are also quite tedious and time consuming. This method was modified slightly by laying out the base lines with tapes alone and with this modification was used for several years with good results.

At the present time, however, we are using a third method which is just as accurate, much less time consuming, and eliminates the necessity and hazards of having a man walk the top of the pile. It is done by laying out the base lines with tapes and checking the right angles with a war surplus bubble sextant. The sextant is also used to determine the height of the pile at the peak and the location of the peak. At each station the following data are taken: (1) distance to the pile from the base line, (2) altitude of the rick with a surveyor's level rod, (3) eye level of the sextant operator by using the sextant and surveyor's level rod, and (4) angle of altitude from the eye level of the operator at the base line to the top of the pile taken with the sextant.

From these data, at each station, on both sides of the pile the cross section of the pile is easily plotted on graph paper with a protractor and straight edge. The area of the cross section can then be measured most easily by using a planimeter. When the cross section is plotted using a scale of 1 inch = 20 feet the planimeter reads directly in square feet if it is traced four times around the figure. The average cross-sectional area is then multiplied by the total length and divided by the cubic feet per unit to get total units of wood in the pile. Another very simple method of determining the area is to cut out the plotted sections with a pair of scissors and weigh them all at once on analytical balances. Then weigh 25 squares inches (100,000 square feet area) at a scale of 1 inch = 20 feet, of the same paper to get the weight per unit area. The units of wood in the pile is then calculated by the following formula:

$$\frac{A \times B \times 100{,}000}{C \times D \times \text{factor cu. ft./unit}} = \text{units}$$

where

A = length of pile in feet
B = weight of plotted areas
C = weight of 25 square inches
D = number of stations

The base lines should be as close to the pile as possible and still leave the top of the pile visible for a sextant reading. The war surplus bubble sextant has a bubble in it, as the name implies, which furnishes an artificial horizon or for our purpose it gives a true level which is used to determine the eye level and also to get the angle to the top of the pile from this true level. It is for all practical purposes a portable transit for vertical angles which needs no tripod or adjustments before the vertical angle is taken. Its accuracy is much greater than can be plotted, since it can be read to degrees and minutes of arc. This instrument cost the government approximately $325 but can be purchased from Herback and Rademan, Inc., 522 Market St., Philadelphia, Pa., for $13.

By using a bubble sextant for the altitude determination a large wood pile can be laid out and measured in 45 minutes with only three men. The calculations are very simple and can be done in less than 2 hours by one man. This is about 4 man-hours per pile. The previous method using tapes across the pile took five men $1^1/_2$ hours to measure and over 3 hours for the calculations. This is a total of over 10 man-hours per pile. The method using a transit would be even more time consuming setting up the instrument and counting squares.

Discussion

MR. ROUZIE: How do you calculate your factor? By measuring several units of wood?

MR. SEYMOUR: Yes. W. W. Krauss, Brunswick Pulp and Paper Co., prepared a paper in 1947 on how to measure the wood to get that factor.

Mr. Pineo gave a preview of equipment and plant layout the group would see on Saturday morning at Brunswick Pulp and Paper Co. Mill

The meeting was adjourned at 9:45 p.m.

37th Annual Meeting

Technical Association of the Pulp and Paper Industry

Hotel Commodore, New York, N. Y.

February 18–21, 1952

Technical Mastics for Corrosion Control and Insulation

W. W. HENDERSON and CHARLES B. WEILER

As PRACTICAL engineers searching for answers to the corrosion nightmares haunting every user and most manufacturers of process equipment and insulations, the authors believe that information that has been developed, after hundreds of satisfactory applications, now represents an answer to problems common to all industry.

When an elevated water tower in a badly contaminated sulphate pulp mill area, where best paint jobs lasted less than a year, still has its more than 4-year-old mastic coating, with only one slight touch-up, and is good for many more years—that is news—good news. When rigid insulation with conventional protective coatings on sulphate liquor storage and other tanks in tough service lasting a little over a year falls off and is replaced with an insulating mastic which 3 years later look like they were done yesterday—there must be a reason.

Realizing that there are many areas and conditions in industry where paints fail irrespective of formula, quality, or cost, it became increasingly evident that conventional products, which could only be applied in thin films—often too permeable to give satisfactory service, were not the answer. Therefore, intense research was started on a heavy coating composed of chemically inert materials so plasticized as to form a film of very low permeability. Materials had to be found to meet the physical qualifications, and a mixture developed that would flow together without skin drying, sagging, cracking, or shrinking, and which must adhere to flat and vertical surfaces under extreme operating conditions without releasing its bond. It had to be equally good wet or dry to permit outside installations, and to be moisture resistant to the point of actually sealing the metal covered against moisture vapor transfer.

A little over a decade ago Erkote Technical Mastics were developed, primarily for the southern pulp and paper industry where corrosive conditions were such that several large mills permitted technically controlled test installations. Their cooperation resulted in products which not only overcame the above-mentioned obstacles but will withstand temperatures cycling from −40 to 300°F. Installations were made at other mills and in other industries. Now these materials are standard procedure with a great many industries in their fight against corrosion and for insulation on both indoor and outside equipment.

Erkote 2X Corrosion Resisting Mastic, the base material, is made in a medium plastic consistency composed of Gilsonite and Mid-Continent asphalt scientifically plasticized and mixed with inert inorganic fillers such as mica and asbestos. It is exceptionally resistant to moisture and to most types of chemical reagents, and tenaciously adheres to properly prepared surfaces without mechanical support. This material is very successful for corrosion control in the sulphate pulp industry, chemical plants, oil refineries, power plants, and many other industries, on oil and chemical tanks, structural steel, conveyors, steel storage bins, elevated water towers, pipe lines, and other such equipment.

To the base material is added ground cork, more asbestos, mica, etc., to produce Erkote 3X Insulating Mastic. Equal in every respect, and much better for long, efficient life outside, to the usual rigid type insulation on medium and low temperatures, in applications 1/4 to 1/2 inch thick it will prevent between 60 and 75% of the normal heat loss through a steel sheet. Within its limitations it definitely cuts out heat losses due to convection currents and has proved itself on all types of equipment under process temperatures up to the point where heat losses are by direct radiation. Where heat losses are due to direct radiation, 3X is not recommended. This product, with low moisture vapor transfer rate (MVTR), is excellent for outside insulation on equipment with temperatures from 240°F. and down, on deaerating heaters, boiler water treating systems, condensers, vapor lines, filtrate tanks, hot water tanks, multieffect evaporators, breechings, precipitator ducts, blow tanks, hot chemical tanks, liquor storage tanks, soap tanks, etc. In sulphate mills it is ideal insulation on liquor clarifiers, dreg washers, and lime slakers. In addition to heat saving, operations are greatly improved by the elimination of turbulence which occurs where temperatures of the process liquors are uneven. These mastics when first installed are black, gradually aging to a gunmetal gray. Where dark color is objectionable, a finisher in snow white or colors may be brushed or sprayed over the mastic after 3 or 4 weeks are allowed for curing. In refineries, on cold insulation for protection against evaporation of high volatile liquids such as aviation gas, naphtha, butane, etc., Erkote 3X insulation with top coats of Erkote Finisher for deflecting the sun's rays, is excellent even on extremely large Hortonspheres (85 feet in diameter at the equator and 68 feet high—17,000 square feet of unbroken insulation). More economical in first cost it has efficient life more than double any other known type.

Erkote 4X Vapor Seal has adequate built-in flexibility to insure against damage due to the normal expansion and contraction of most equipment. In addition, independent recognized laboratory tests show a MVTR of 0.002 ounce per 24 hours per square foot on the base material Erkote 2X. Erkote 4X MVTR is between this figure and that shown below for 4XB.

Erkote 4XB, slightly higher in cost, is Erkote 4X to which a fire retardant has been added giving resistance to supporting combustion in 5 days and which also materially improves plasticity. The MVTR is 0.001 ounce per 24 hours per square foot.

Other mastics are used for waterproofing and beautifying mill and industrial buildings, office buildings, schools, etc., of concrete, brick, cinder block, ceramics, and other materials—adding many years to their useful life.

There are many excellent paint systems available today and they have their rightful spot in all industrial maintenance and corrosion control setups. Where they do the right kind of a job, by all means use them. But where the best of paints fail so rapidly that continuous cleaning and repainting costs represent maintenance problems entirely out of proportion with equipment values over the long pull—say where the best paint job must be renewed within a year (and don't lose sight of the fact that it begins breaking down much sooner and probably during most of its life gives less than a fair measure of protection)—the cost of that paint job cannot

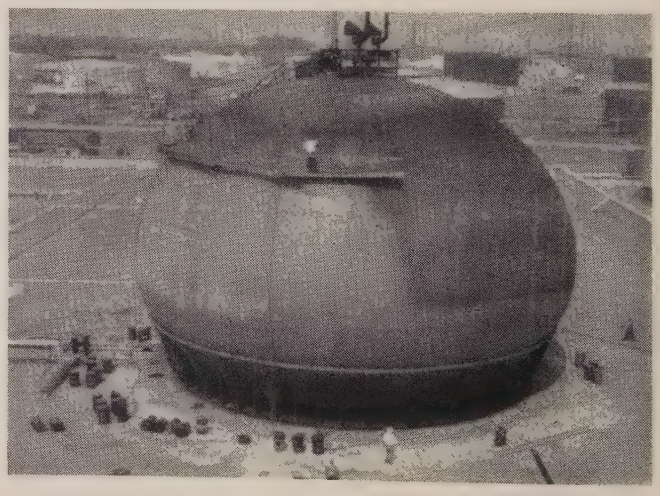

Fig. 1. Coating a Hortonsphere

W. W. HENDERSON, W. W. Henderson & Sons, Pensacola, Fla., and CHARLES B. WEILER, Earl Paint Corp., Utica, N. Y.

possibly be used as a measuring stick against the first cost of a product which has a proved record on the same or comparable equipment under similar conditions of four or more times the best service paint systems provide—with full protection all the way. A mastic job is applied in thickness equal to 25 or 30 coats of paint.

High temperatures are best served with conventional types of rigid insulation, although many perfectly good installations fail where they are not completely protected from moisture and fumes by the finishing coatings. To support this statement, let us review the history of the art of coating insulated equipment for protection against the elements.

Originally the method consisted of applying the insulating block and some asbestos cement and then painting the outside with regular paint or some asphalt preparation, or banding roofing paper over the cement. None of these methods were particularly successful. About 1920 an asphalt emulsion, which seemed to be the answer to weatherproofing, was developed. In an effort to eliminate freight costs on the water in these emulsions which added to installation cost, some attempts were made to produce emulsions at the job site, which failed. The insulation industry then purchased emulsion from original manufacturers and sold it under their own trade names. Because of the greatly increased demand for such a coating, or because original patents have run out, many insulation manufacturers make their own emulsions or have them made to their specifications.

Fundamentally, the emulsions are still about 50% water, have little or no bond, and permit the absorption of water or moisture vapor through them to the main insulation. In actual practice their use is still a gamble. Undoubtedly you know of identical equipment installations under identical operating conditions, insulated and coated by the same crews using the same materials where one unit stands up and the other fails completely. Insulators know this but until recently there was not much they could do about it. The insulation itself meets all requirements and should last indefinitely if it could be protected from moisture and fumes. But with a coating which, at best, was a hit-and-miss proposition, they could only make the application and hope that it would stay put for the usual one year they had guaranteed.

A Pennsylvania industry now has more than 50,000 square feet of expensive insulation prematurely failing because the high MVTR of the emulsion has also permitted various deleterious fumes to penetrate through and corrode the supporting wire mesh. Near Pensacola a large industry is now replacing thousands of square feet of low-temperature rigid insulation in operation less than two years with mastic insulation for the same reason.

We believe that all major insulation manufacturers will eventually welcome a finish coating that will definitely protect their product after installation so their customers will receive a fair measure of service from their investment. We also feel that industry will not hesitate to specify that insulators use

Fig. 2. Chip conveyor bridge that has been coated

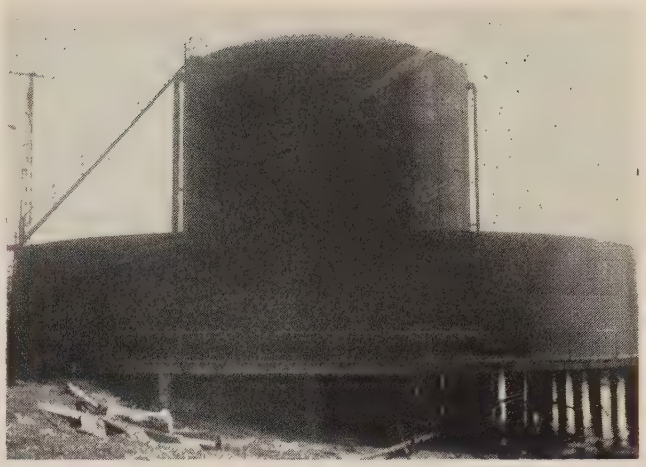

Fig. 3. Fuel oil tank and dyke coated with corrosion-resisting mastic

vapor seal coatings that will give several years' complete protection on their equipment instead of those they cannot be sure will stand the gaff even for one year. Many plants are using glass fiber insulation, such as Foamglas, over which the usual specification calls for a layer of mastic, a wrapping of glass fiber cloth, and a second application of mastic—a costly application. Since Foamglas-type of insulation has no measurable MVTR, and does not pick up moisture between the factory and the job as most other rigid insulations, the protective coating is to prevent thermal shock during rainstorms with resultant shattering of insulation. This hazard is economically eliminated by having chicken wire stretched over the Foamglas and 4X mastic sprayed over the entire surface. The coating completely surrounds the individual wires, including the twists and tie wires. Since there is no water in 4X mastic to start with and none can penetrate because of the extremely low MVTR the usual rusting of the wire which causes insulation failures cannot occur.

Since all other types of rigid insulation pick up atmospheric moisture by the time they are applied (magnesia will often pick up several times its original weight—other types in proportion), care must be exercised to see that all equipment is brought up to operating temperature so that all moisture is driven out of the insulation prior to installing the mastic. If job conditions are such that mastic must be applied prior to drying out the insulation there might be some blistering requiring touch-up later. However, our opinion is that this can be minimized by incorporating expansion joints to permit the escape of the moisture—the only cause of the blisters.

Far too little attention is given to the importance of eliminating all moisture from rigid insulation before applying final coatings. Few have seemed interested enough to measure this moisture or deviate from regular insulating procedures to eliminate it. However, this is now a real *must* with certain outstanding industries. Some insulation manufacturers insist that emulsions with high MVTR must be used to permit the moisture to escape. We cannot agree with this theory. Common sense tells us that by putting an emulsion containing 50% or thereabouts of water over rigid insulation, the water must go somewhere. It cannot possibly all evaporate and some will form on the chicken wire holding the emulsion in place, and settle on the twist causing rust. Prove this to your own satisfaction. Break into an otherwise perfect looking insulation with the usual emulsion top coating a short while after it is installed. You will find the twist rapidly rusting away to break entirely in a few months and let the entire coating, and often the insulation, fall off entirely.

This has become such a problem with insulation manufacturers and industries alike that many are specifying stainless steel wire at about 16¢ a square foot—if they can get it.

Fig. 4. Precipitation duct work coated with mastic

Vegetable cork presents a very definite high moisture pick-up between manufacture and application. No one knows how much or what happens to it after the equipment is operated. Most applications are made with hot asphalt, and few applicators seem interested in trying other materials or methods of application. Again, no one knows definitely what happens to the hot asphalt when the equipment reaches operating temperatures. Our experience leads us to believe that it becomes brittle and loses its vapor sealing qualities, definitely permitting moisture penetration, frosting, and rapid deterioration.

In a nationwide chemical industry several successful 4X Erkote Vapor Seal applications over cork have replaced the usual asphalt coatings, providing a definite vapor barrier. Service to date is rather conclusive that the life of the insulation has been indefinitely extended.

For new cork board installations either the 2X or 4X type is sprayed directly to the cork without any preparation and effectively seals the insulation.

From constant contacts with current corrosion-resisting and insulation practices it is believed that the following recommendations are worthy of careful consideration regardless of the magnitude of the insulation problems.

No paint or mastic job will be successful unless the surface is first completely cleaned and properly prepared. Frankly, shop prime coats on fabricated steel and tankage, unless applied over expertly prepared surfaces, do more harm than good in most instances. We have found a distinct advantage in eliminating shop coats wherever final protective coatings can be applied within 3 or 4 months after erection. Mild rusting actually permits better surface preparation. Mill scale, grease, etc., usually covered by the shop coat to continue its corrosive work, break down and are easily removed by power brushing and other cleaning methods. The customer should receive credit for eliminating the shop coat.

After cleaning we recommend preparing all metal by passivation with a metal conditioner which chemically unites with the metal surface to make it insoluble, actually a part of the surface itself not dependent on adhesion to remain so. This insolubility checks the natural tendency of iron and steel to react to moisture and other conditions to form corrosion. On new metal passivation actually imparts a slight etch which assures better adhesion for the protective paint or mastic coatings.

The priming coat is most important on steel surfaces. We have found no. 1753 Erkote chromate primer best for all-purpose use under such highly successful finish coats as Erkote no. 11 gray or no. 36 black chemical resisting tank enamel, Erkote no. 40-A black tank paint, Erkote no. 501-L structural steel, or other high-grade industrial paint or mastics. Where both moisture and chemicals are causing corrosion Erkote no. 1347 reactive primer is excellent under mastics or any of the above paints.

In the sulphate pulp industry a real tough situation exists on hot brown stock washing systems. Many paints last only a few weeks. Until recently the practice was to apply high-cost paints and hope—at least for the first month or so—then do it all over again or forget it altogether which seems to be the line of least resistance. We believe we have a system that will give longer and more complete protection than any other now available. Economical in first cost it now indicates low maintenance. Test applications are being carefully watched and more information will be available soon.

In the low-temperature field for both inside and outside insulation service, Erkote 3X insulation is economical in first cost, is as efficient in preventing heat loss as any insulation available today, and is so much better than most in many respects (such as low MVTR and exceeding long life) that its manufacturer does not hesitate to assume responsibility for satisfactory service on every installation made after complete temperature and other pertinent data have been made available.

When Erkote 3X mastic insulation is applied on cold equipment a minimum of 2 and preferably 3 weeks should be allowed for complete curing before operating temperatures are turned on. It is important that these applications are started only after all connections to equipment are complete and scaffolding removed as protection against mechanical damage before the mastic has cured.

On hot equipment in operation at the time of application it is vital to the success of the application that accurate data on operating temperatures, manipulations of processes which might vary temperatures, and other such data are given by the owners, and arrangements made to maintain normal operating temperatures to the closest possible margin during and immediately following application. Intermittently hot and cold conditions, over which only the owner's operators have control, should not be permitted to ruin what would otherwise be a perfect installation.

Satisfactory mastic insulation, or any other insulation job, for that matter, is no different from the many other applications for hot equipment. You would not think of starting up a newly bricked boiler without thoroughly drying out and

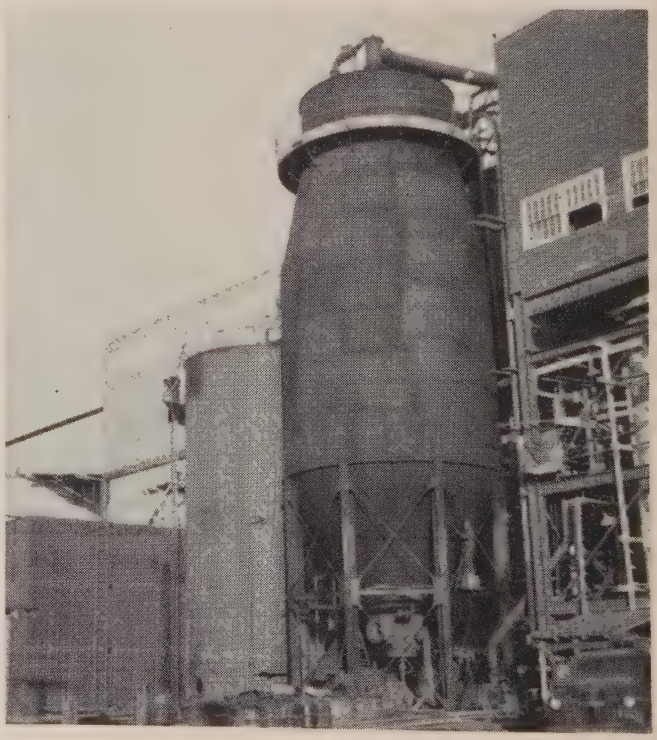

Fig. 5. Coating on a blow tank

curing the brickwork under uniform heating—why damage a costly insulation job by ignoring the specifications for installation and proper curing you agreed to when purchasing?

Manufacturers have incorporated in present conventional insulation best practices obtainable for their temperature ranges, and most products should, if properly protected from moisture vapor, last indefinitely. In our opinion the application of a finishing cement over insulation with an emulsion for weather protection has not been the answer. We believe there is real protection in the mastics.

We believe that present methods of installing the insulation itself are satisfactory, but that any finishing cement, except to butter the joints to provide smooth surface, should be discouraged. Instead the insulation should be covered with a layer of galvanized chicken wire and the entire surface sprayed with Erkote 4X mastic. This completely encases the chicken wire thus insuring long, corrosion-free life for the wires and insulation. The spray kit, especially developed for this purpose, is used to apply mastic. Use 4XB if the job must have fire-retardant qualities quickly.

Some may question the use of the chicken wire. Actually, when properly sprayed on, the bond between the mastic and the insulation block is greater than the cohesion of the insulating material and there might be a tendency for the insulating block to pull apart. The chicken wire is merely to hold the blocks in place and prevent this separation.

Where blanket-type insulation is used (Fibreglas, Eagle-Picher, and other rock wool makes) the blankets should have an expanded metal mesh on the outside, and this should be sprayed with 3X insulating mastic, using the spray kit. To provide full coating over and around the metal mesh and present a smooth finish on the outside of the blanket. With this cork-filled mastic a slightly higher MVTR is obtained but experience proves that when metal is completely coated, lath rusting is prevented, and the resulting insulating value is considerably higher than with the usual cement with chicken wire and emulsion.

In addition to the above points dealing primarily with corrosion control in insulation supporting structure, there is a very real labor and total cost saving to be considered. The normal job requires installation of insulation and a layer of chicken wire. Up to this point, the same applies to our recommended method. Here is where the savings enter the picture. One more step—a sprayed coating of mastic completes the job. Not so with the usual method, which still requires an asbestos cement coating, another layer of chicken wire, and finally two coats of emulsified asphalt troweled on by hand. The saving in handling labor alone is impressive since the cement weighs approximately 4 pounds per square foot, the emulsion another 4 pounds per square foot as against approximately 1 pound per square foot of mastic.

Where hydraulic setting insulation cements are used over mineral wool forms of blocks or boards, the use of a heavy mastic vapor seal is required. This type of insulating and finishing cement does provide excellent protection structurally but offers very little resistance to the passage of moisture vapor through the insulation to the supporting steel underneath when the equipment is out of service. When the mastic is applied, after the equipment has reached operating temperature and the entrained moisture driven out, we believe the insulation will maintain operating efficiency indefinitely. The value of this method has been demonstrated by users of this type of finish, and several of the large utilities are now specifying it as standard practice.

In closing the authors reiterate their desire to be helpful to industries who must use protective coatings and insulation, as well as to those who manufacture and those whose business it is to apply it. No claim is made that mastics are a "cure-all." The limitations within which no application will fail to give outstanding service are known, and with industry-wide opportunity within its range, it would be foolish to recommend them where there is the slightest doubt of success.

An Industrial Lecture Program for Students of Chemical Engineering

L. C. JENNESS

MANY papers have been written on the subject of cooperation between industrialists and universities or colleges in the training of young men for positions in industry. It is a pleasure to be able to report on the effectiveness of a procedure that is utilized at the University of Maine to accomplish this this purpose. This plan takes advantage of participation by industrialists in the teaching of college students who expect to enter the field of pulp and paper or allied industries. The industrial lecture program is now in effect for the third year, and is considered to be very successful by students, faculty and representatives of industry.

A number of circumstances contributed to the initiation of this program. In the first place, there are very few people with varied industrial experience in the pulp and paper field who choose to make a career of teaching. In the second place, it was observed that any connection with industrial projects, or industrial personnel, seemed to stimulate interest on the part of the students. It was largely for these reasons that when Clifford Patch of the Eastern Corp., a member of an advisory committee for the university, recommended the above procedure his suggestion was acted upon.

The general idea of the program was presented to the executive committee of the Maine-New Hampshire Section of TAPPI in the Spring of 1948. The members of that group were in sympathy with the idea and assisted in planning a program of speakers for the Fall semester of the academic year 1948–49. Members of this section of TAPPI, and the companies they represent, have continued to support this educational program, as have several other sponsors from areas outside the states of Maine and New Hampshire.

ORGANIZATION

The following objectives were considered desirable in formulating the program of industrial lectures:

1. That the lectures be given to groups of students who were interested in pulp and paper and who would receive credit for these courses toward a degree.
2. That the lectures be given on the campus during the day of a regularly scheduled class.
3. That the lectures be followed by discussions and examinations conducted by full-time members of the university faculty.
4. That the lectures be as technical as deemed practicable, consistent with the background of the students.

Accomplishment of these objectives required consideration of several factors. Specialization of students in the field of pulp and paper is initiated at Maine in the fourth year of the chemical engineering curriculum. In addition to those students who elect to specialize in this field, there are several others who major in chemical engineering, or other branches of engineering, who have some interest in the pulp and paper industry. Most of these students would have a good background in chemistry, mathematics, thermodynamics, and the unit operations of chemical engineering. They would, however, be at the introductory level of specialization in the applications of these principles to the pulp and paper processes.

It was recognized that accomplishment of the second objective, daytime lectures, would constitute a sacrifice on the part of the sponsors. Since Orono is quite centrally located among the mills in Maine, however, this procedure was considered feasible. Student schedules are arranged so that a double period once a week can be devoted to the lecture in order to take as much advantage as possible of the experience of the

L. C. JENNESS, Head of the Department of Chemical Engineering, University of Maine, Orono, Me.

visiting lecturer. This lecture period is accompanied by separate recitation and examination periods, which are coordinated with suitable text assignments, and are conducted by members of the university faculty.

COURSES

This type of lecture program has been followed in three courses, pulp technology, paper technology, and pulp and paper mill equipment. The course in pulp technology is given in the Fall semester of the senior year, for the regular four-year students, while the other two courses are given in the Spring semester of the senior year. In each of these courses approximately 16 visiting lecturers come to the campus each year. A majority of the speakers in the pulp and paper technology courses are men who have been close to the practice of the manufacture of pulp and paper or to the supply of raw materials for these processes. The prime source of lecturers for the equipment course has been representatives of companies which supply equipment for the production of pulp and paper or paperboard.

Subject Matter. The subject matter in each course is divided into about sixteen main topics, each of which is scheduled, well in advance of the opening of the semester, for a particular week of the year. The speakers are then contacted and informed of the complete program so that they can best prepare the subject matter for their particular assignment.

The course in pulp technology is based on lectures on each of the following topics:

Structure of wood
Chemical properties of wood
Wood operations
Preparation of pulp wood
Mechanical pulping, general
Mechanical pulping, grinders
Sulphite pulping, preparation of sulphur dioxide
Sulphite pulping, acid systems
Sulphite pulping, cooking, and recovery
Semichemical pulping
The soda process
The sulphate process
Soda and sulphate recovery
Peroxide bleaching
Chlorine bleaching

Subjects of lectures in paper technology include:

Personnel relations
Beating and refining
Fillers and loading
Paper sizing
Paper coloring
Paper machine—wet end
Paper machine—dry end
Paper coating
Finishing and converting
Paper testing and specifications
Waste papers
Coarse papers (bag and board)
Special papers (tissue and towels)
The graphic arts

A typical series of lectures in the pulp and paper mill equipment course is as follows:

Mechanical phases of pulp mill operation
Modern methods of stock preparation
Modern pumping equipment for the pulp and paper industry
Electric motor and steam turbine applications in the pulp and paper industry
Pulp and paper mill instrumentation
Chemipulp systems
Paper machine drives
Packing clinic
Ross systems in the paper mill
The spiral heat exchanger and its applications in the pulp industry
Alloy linings for digester service
The cylinder paper machine
Disk refiners, materials handling equipment

A careful survey of student reaction to this program has been made frequently. It is generally agreed by the students that the lectures are desirable for the following reasons:

1. The lecturers are in a position to speak with authority on each of the various subjects they volunteer to discuss. In other words, it would be very difficult to find any one person who had extensive experience in all of the fields of application that are covered in these courses.

2. By virtue of their contact with industry the speakers emphasize the phases of subject matter that are of greater value from the standpoint of production.

3. A high degree of interest is maintained due to the obvious fact that the speaker has applied the principles being discussed to the production of a salable product.

4. That the student has an opportunity to meet in person a variety of individuals who have contributed to the development of the field of pulp and paper. This situation tends to broaden the horizon of the student and make him more appreciative of some conditions in industry that are seldom, if ever, discussed at length in textbooks.

Although the students and staff members have benefited most from this program, some comments from the speakers are of interest. They believe that the industry as a whole, and the companies they represent in particular, will get an eventual return on the investment involved through better man power. The speakers have all made an attempt to cover broad phases of subject matter rather than confining themselves to the particular conditions with which they are more familiar. As a result of this practice, many of them feel that they have broadened their own concepts of the subject matter they have presented to the class.

Several of the speakers have prepared a complete paper on a particular topic prior to its presentation to the class. Others have cooperated in the writing of such a paper after the class discussion. These efforts have resulted in the publication, under the auspices of the Department of Industrial Cooperation, of most of the lectures that were given in the pulp and paper technology courses during the last two years. These appear in the Nov. 30, 1950, issue of the *Paper Trade Journal* and are available in textbook form.

It is my considered opionion that there is a demand for more engineering graduates who have had the benefit of these courses. Statistics show that the per capita consumption of paper and paper products has increased exponentially over the last forty years. In addition to this trend, recent census data show an increase of population in the United States. It is further expected that the continued development of the application of technology to the production of pulp and paper will create a greater demand for chemical, mechanical, electrical, and civil engineers with the type of background provided by these industrial lectures.

Operation of these lecture programs at the University of Maine has attracted the interest of good students whose attention might otherwise have been diverted from this field. During the last three years the number of students majoring in pulp and paper has increased over sixfold. Some of this increase was due to the popularity of our recently initiated five-year program which includes these industrial lectures. This is considered a desirable objective of the program and it is hoped that the program will continue to accomplish the purpose of producing more graduates who are better trained for entering the pulp and paper and allied fields.

The writer wishes to express his personal appreciation, and that of the administration at the University of Maine, to all the speakers who have participated in these programs. It is recognized that each of these men has devoted many hours to the preparation, as well as the presentation, of these lectures. We are also grateful to the personnel of companies represented by these speakers for making their services available to us.

Received Dec. 29, 1950. Presented at the Annual Meeting of the Technical Association of the Pulp and Paper Industry, New York, N. Y., Feb. 19-22, 1951.

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Calendar of TAPPI Meetings

NATIONAL

Annual Meeting, Commodore Hotel, New York, N. Y., February 18–21, 1952.

LOCAL SECTIONS

LAKE ERIE SECTION:
December 21, 1951, Hickory Grill, Cleveland, Ohio

SOUTHEASTERN PULP AND PAPER SOCIETY:
November 30, 1951, Jacksonville, Fla.

DELAWARE VALLEY SECTION:
November 29, 1951, Engineers Club, Philadelphia, Pa.

CENTRAL DISTRICT, EMPIRE STATE SECTION:
December 7, 1951, University Club, Syracuse, N. Y.

OHIO SECTION:
December 11, 1951 Battelle Institute, Columbus, Ohio.

PACIFIC SECTION:
January 15, 1951, Seattle, Wash.

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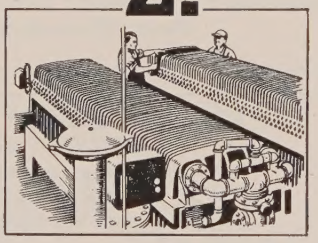
2.



FILTER-AIDS —for White Water

A filtration system using Dicalite filter-aids, which will afford continued re-use of practically all machine water can be employed successfully on most board, pulp and paper machines. One large board mill, operating two of their four machines on a closed system, filters and re-uses all the machine water. They report savings in power and steam alone are sufficient to pay materials and operating costs, while realizing in addition the recovery of fine fibers as well as appreciable increase in felt life.

TECHNICAL DATA on both the above uses of Dicalite materials will be sent on request. A Dicalite Engineer will gladly be of any additional service possible.

DICALITE DIVISION, GREAT LAKES CARBON CORPORATION

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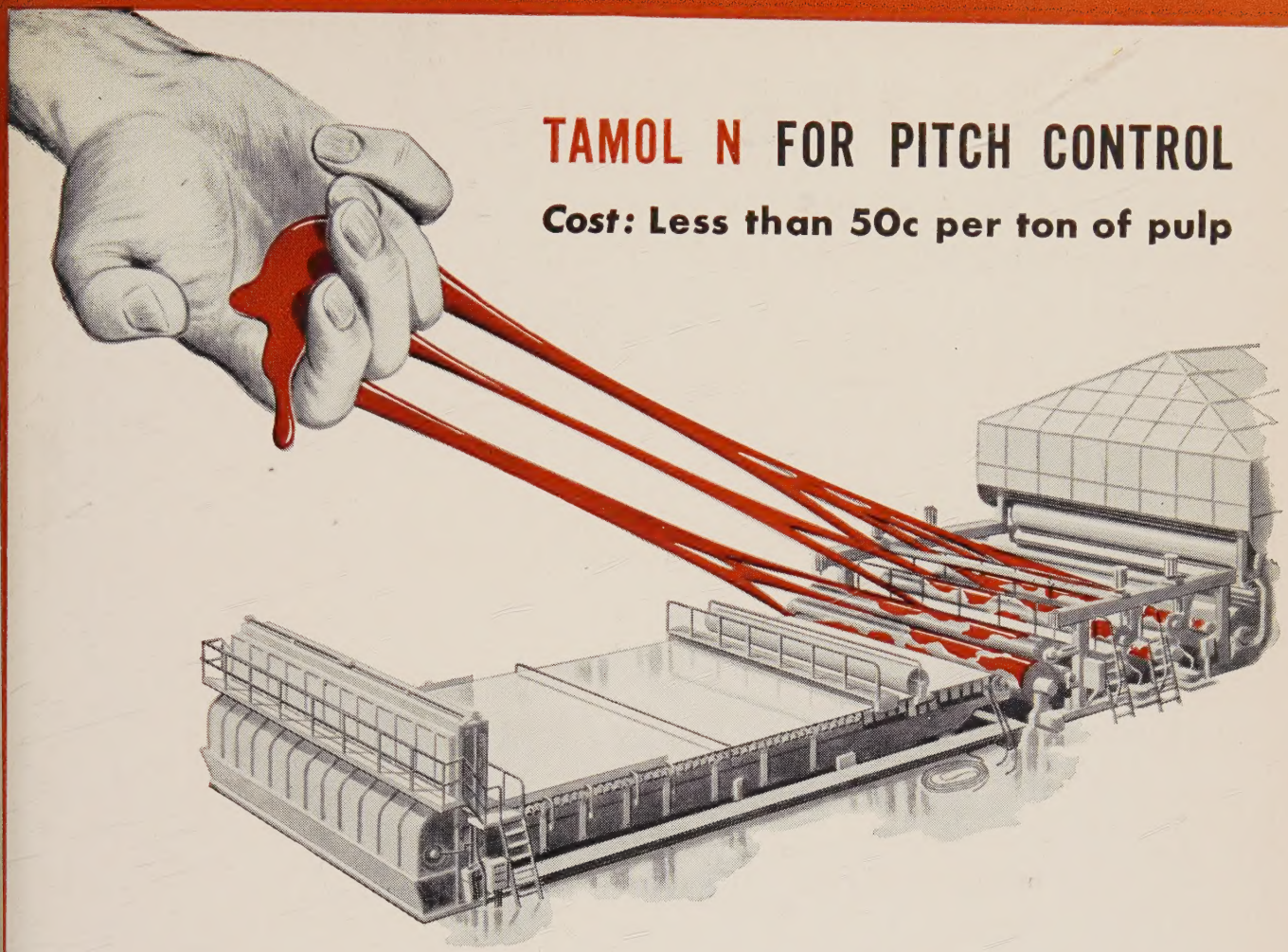

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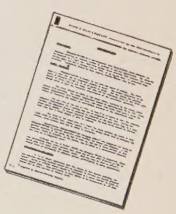

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